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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 59 MAY, 1948 No. 5

CONTENTS

Cerebral Angiography . . . . . JOHN R. GREEN, M.D., AND ROMAN ARANA, M.D. 617

Roentgen Considerations of Pyelonephritis in Small Kidneys . . . . . EUGENE P. PENDERGRASS, M.D., RICHARD H. CHAMBERLAIN, M.D., AND FRANK P. BROOKS, M.D. 651

Roentgenological Manifestations of Intrathoracic Injury Due to Missiles . . . . . WILLIAM A. EVANS, JR., M.D. 662

Pulmonary Cavities "Below the Diaphragm" . . . . . PHILIP MORGENSTERN, M.D., AND IRVING PINE, M.D. 677

Gastric Tuberculosis . . . . . H. R. MORRIS, M.D. 682

Tumors of the Small Intestine . . . . . PERCY DELANO, M.D. 685

A Simplified Method of Roentgen Pelvicephalometry . . . . . ANGUS K. WILSON, M.D. 688

Solitary Unicameral Bone Cyst of Right Ilium . . . . . G. W. HEUBLEIN, M.D., AND COLONEL C. L. BAIRD, M.C. 699

Agenesis of the Vertebral Bodies—A Cause of Dwarfism . . . . . MARGARET J. GIANNINI, M.D., FRANK J. BORRELLI, M.D., AND WILLIAM B. GREENBERG, M.D. 705

Isolated Dislocation of the Lesser Multangular Bone . . . . . D. ALAN SAMPSON, M.D. 712

Granulosa-Cell Tumor of the Ovary . . . . . ROBERT D. MORETON, M.D., AND EUGENE T. LEDDY, M.D. 717

Comparison of Intradermal and Ocular Methods of Testing for Sensitivity to Diodrast . . . . . ARTHUR G. SINGER, JR., M.D. 727

Roentgen-Ray Calibration of Photographic Film Exposure Meter . . . . . L. J. DEAL, J. H. ROBERSON, AND F. H. DAY 731

Editorial

Affections of the Respiratory Tract in Individuals Exposed to Cotton Dust 738

Society Proceedings, Correspondence and News Items 740

Book Reviews 746

Books Received 748

Department of Technique

An Improved Method of Visualization of the Sigmoid . . . . . CAPTAIN GILBERT H. FLETCHER, M.C. 750

Prevention by Ultraviolet Radiation of Algae Formation in Wash Tanks . . . . . WILLIAM S. ALTMAN, M.D. 753

Abstracts of Roentgen and Radium Literature 754

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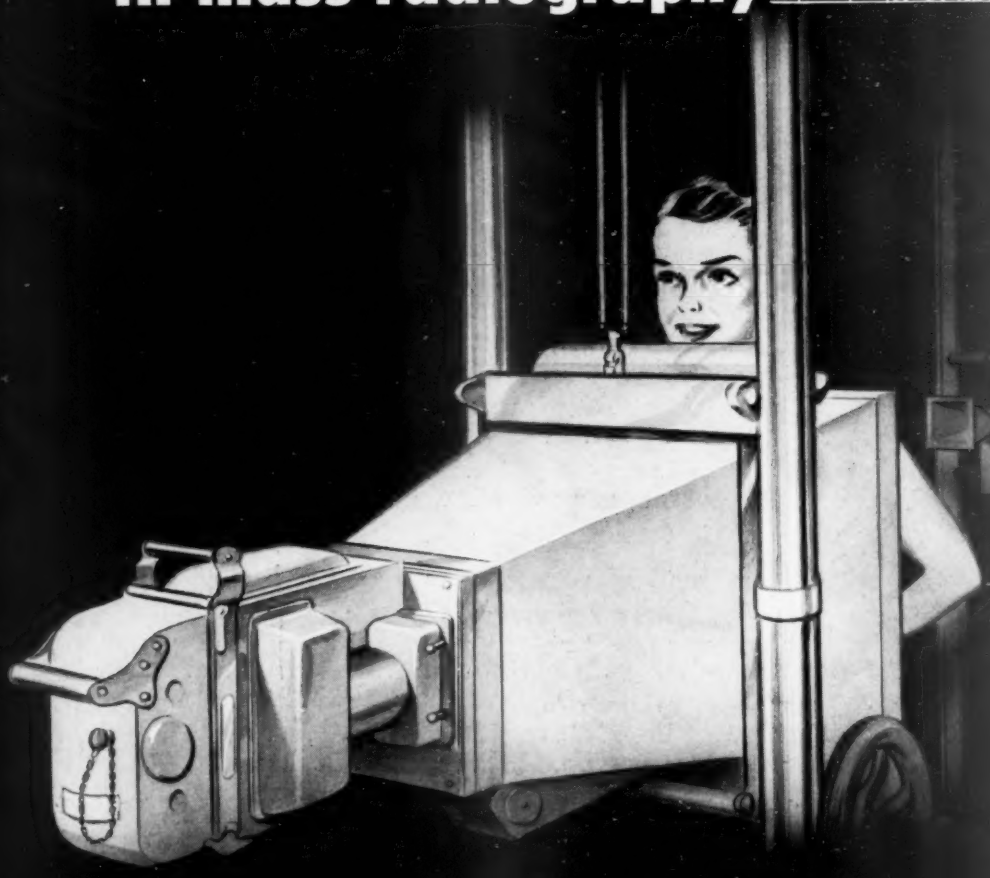

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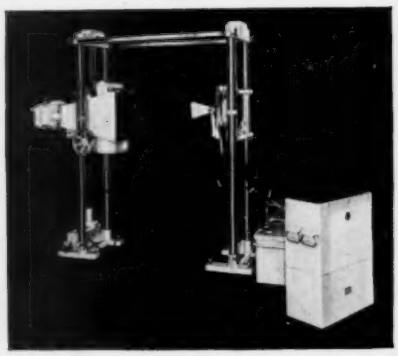

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 59 MAY, 1948 No. 5

CEREBRAL ANGIOGRAPHY

A CLINICAL EVALUATION BASED ON 107 CASES*

By JOHN R. GREEN, M.D†., *and* ROMAN ARANA, M.D.‡

CHICAGO, ILLINOIS

IN JULY, 1927, Egas Moniz[12] of Lisbon, published the first roentgenologic studies of the skull following the perfusion of the cerebral vessels with radiopaque materials. Seventy per cent strontium bromide was used at first, but was discarded in favor of 25 per cent sodium iodide solution, and since 1931, of thorotrast.[14] The method was introduced into Germany by Löhr and Jacobi,[42] in 1931. The medical literature of European neurologists and neurological surgeons has shown increasing applications of cerebral angiography since that time. Signs of interest in this subject began to appear in America in 1936 (Loman and Myerson[44]). Since 1938, when Elvidge[20] reviewed the literature and evaluated the method on the basis of his experiences at the Montreal Neurological Institute, contributions have been made by other clinics (Turnbull[60] Freeman *et al.*,[21] Gross,[28] Peet and List,[48] Govons and Grant[26] and others).

Since the opening of the Illinois Neuropsychiatric Institute, angiography of the brain has been used in a wide variety of neurological problems. We have used principally the percutaneous method taught us by Dr. Kentaro Shimidzu[54] at that time voluntary assistant on the service. Our observations regarding the technique and clinical usefulness of the method, based on over 107 cases, are herein discussed.

ANGIOGRAPHIC ANATOMY

In order to recognize cerebral lesions which affect the vasculature, an intimate knowledge of the more common anatomic landmarks is essential. Two pairs of arterial trunks bring blood to the brain. The two carotid arteries and their branches supply the frontal, parietal, lateral portions of the temporal lobes, anterior half of the thalamus, and the corpus striatum. The two vertebral arteries and their branches supply the caudal region of the brain, including the inferior portions of the temporal lobes, occipital lobes, posterior part of the thalamus, brainstem and cerebellum. It follows, therefore, that the region of the brain which is affected by a lesion will determine the arterial system to be injected with the contrast substance.

The internal carotid artery (Fig. 1) enters the base of the skull and follows the carotid canal. It runs perpendicularly upward and then turns abruptly forward and medially

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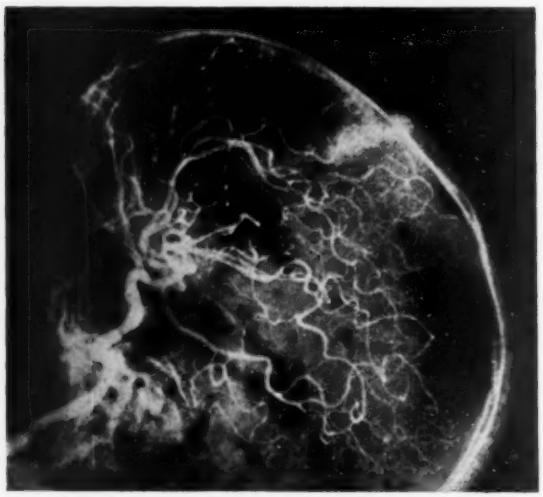

Fig. 1. Normal arteriogram (carotid injection). The posterior cerebral artery is filled in only 34 per cent.

toward the anterior portion of the apex of the petrous pyramid. Here, the artery emerges from the foramen lacerum to pass along the body of the sphenoid bone. It enters the middle fossa of the skull, pierces the external layer of the dura mater, and then passes horizontally forward, in an S-shaped curve, in the lateral wall of the cavernous sinus. Just below the lesser wing of the sphenoid bone, the vessel turns sharply upward to reach the medial side of the anterior clinoid process, which it grooves. During this vertical portion of its course, the artery pierces the inner layer of the dura mater, and then doubles sharply backward to pass laterally, below the anterior perforated substance, to the medial aspect of the lateral fissure where it pierces the arachnoid and divides into its terminal branches. Egas Moniz[14] has coined the term, "siphon carotidien," for that portion of which redoubles upon itself (Fig. 1). Considerable variability of the carotid siphon exists but probably no more than in vascular structures generally. Within the cranial cavity, the internal carotid artery provides small twigs to the wall of the cavernous sinus, meninges, adjacent cranial nerves and to the pituitary gland. The *ophthalmic artery* can be seen to arise from the anteromedial side of the vertical portion of the internal carotid artery, and to pass anteriorly, below the optic nerve through the optic foramen, into the orbit. The *anterior chorioidal artery* (Fig. 1) is a small vessel which branches posteriorly from the internal carotid artery, near its termination into the anterior and middle cerebral branches and close to the origin of the posterior communicating artery. It passes backwards along the optic tract to enter the chorioidal fissure in the lower part of the inferior horn. It supplies the choroid plexus of the lateral ventricle on the same side, hippocampus and portions of the globus pallidus and posterior limb of the internal capsule. It is occasionally of great diagnostic importance in the localization of intracranial lesions, and was seen in 59 per cent of our cases. The *posterior communicating artery* was visible in 43 per cent of our studies, branching posteriorly somewhat near the termination of the internal carotid artery. Occasionally it seemed to replace the posterior cerebral artery (Fig. 1) or to take origin from the middle cerebral artery. The *posterior cerebral artery* (Fig. 1) appeared on 34 per cent of the carotid arteriograms, and in all of the successful vertebral arteriograms. In the former instances, it is filled through the posterior communicating artery, and in the latter it is formed by the bifurcation of the basilar artery, shortly before or after the origin of the superior cerebellar arteries. The posterolateral (thalamogeniculate) and posteromedial (thalamoperforating) arteries are small vessels (Fig. 3) which arise mostly afrom the proximal portion of the posterior cerebral artery and carry arterial blood to the thalamus, lateral geniculate body, and the posterior limb of the internal capsule. These vessels are well seen in the vertebral arteriograms of our series. The posterior cerebral artery passes laterally and backward over the cerebral peduncles, completes the circle of Willis and then continues to the inferior surface of the hemisphere, where it divides into its terminal branches: (1) *anterior temporal*, (2) *middle or posterior temporal* (Fig. 1 and 2),

(3) *parietal-occipital* (Fig. 1, 2 and 3), and (4) *the calcarine artery* (Fig. 2 and 3). These vessels supply the medial and inferior aspects of the occipital lobe, and the inferior portion of the temporal lobe, except for the pole. An extensive anastomotic network exists.

The *anterior cerebral artery* (Fig. 1 and 2) is the smaller of the two major terminal branches of the internal carotid artery. It is joined to the contralateral anterior cerebral vessel by a short connecting channel, the *anterior communicating artery*, and ascends vertically, anterior to the lamina terminalis. Both anterior cerebral arteries appeared in 36 per cent of the cases and the ipsilateral vessel was visible in the remainder of the studies, except for pathologic occlusions in 4 instances. The first important

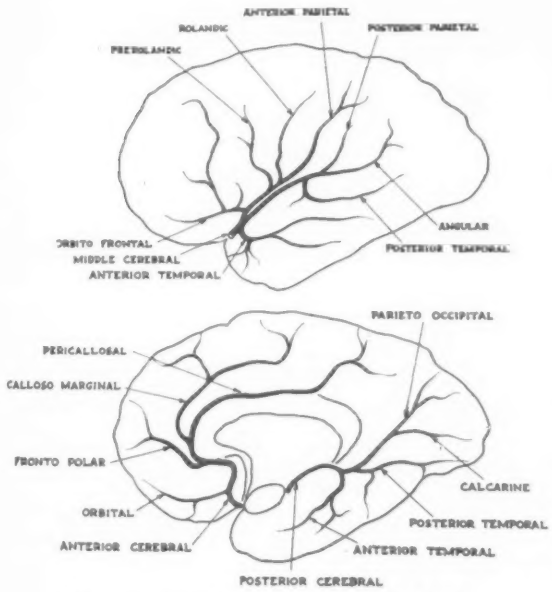

Fig. 2. Arteries of the brain (Bailey).

branch is the medial striate artery (recurrent artery of Huebner). This vessel is minute and arises near the level of the anterior communicating artery, to run backward into the anterior perforated substance to supply the head of the caudate nucleus and adjacent portions of the putamen and internal capsule. It has not been identified with certainty in our examinations. Two larger branches of the ascending

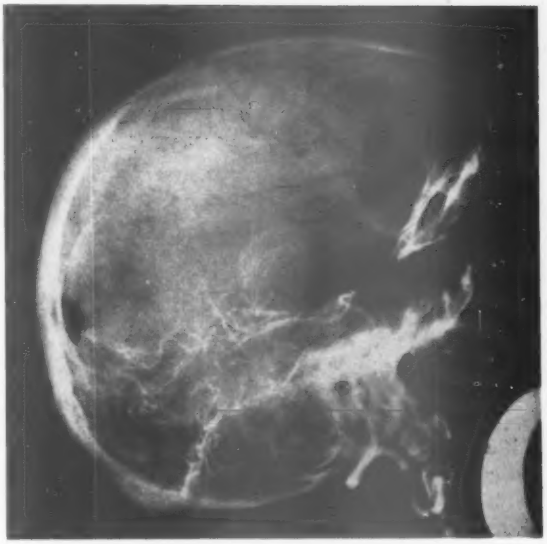

Fig. 3. Normal arteriogram (vertebral injection).

portion of the anterior cerebral artery are commonly seen: (1) *orbital* (Fig. 2), and (2) frontopolar (Fig. 1 and 2). These vessels supply the olfactory lobe, gyrus rectus, and the medial portion of the orbital gyri. After giving off these branches, the anterior cerebral artery turns posteriorly to outline the genu of the corpus callosum and passes along the superior aspect of the corpus callosum. It is now termed the *pericallosal* artery (Fig. 1 and 2), and continues posteriorly toward the splenium of the corpus callosum, where it anastomoses with the posterior cerebral artery. The pericallosal artery usually gives off three branches: (1) *anterior*, (2) *intermediate*, and (3) *posterior medial* (Fig. 1). These vessels pass along the callosal marginal gyrus and may appear to form a separate artery (*callosal-marginal artery*) (Fig. 2), which parallels the pericallosal artery. This is rarely a single vessel, but is formed by arteries which successively occupy the callosal marginal fissure. These vessels supply the whole medial surface of the frontal and parietal lobes.

The *middle cerebral artery* is the larger of the two major terminal branches of the internal carotid artery. It passes laterally over the anterior perforated substance into the sylvian fissure, where it divides into

its cortical branches. These vessels curve outward over the opercular margins of the lateral fissure and spread over the convex surface of the brain. The major branches of the middle cerebral artery are quite constant, but their arborizations are not. The *ascending frontoparietal artery* which supplies the lower frontoparietal region, adjacent to the rolandic fissure, is constantly seen and assumes the configuration of the Greek letter ψ. This vessel branches (Fig. 1 and 2) to form: (1) the *pre-rolandic*, (2) the *rolandic*, and (3) the *anterior parietal arteries*. The small branches from the middle cerebral artery to the basal ganglia have not been of aid in this study. The three terminal branches of the middle cerebral artery generally arise in one of three ways: (1) separately, in 47.7 per cent of our cases, (2) two trunks, of which one soon divides, in 34.3 per cent of our studies, or (3) from a common trunk which gives rise at once to three terminal branches, present in 10.4 per cent of our arteriograms. Egas Moniz[12,14] has termed these three vessels as the "group Sylvienne" and deems them to be the "arterial axis of the brain," from the standpoint of arteriography. They cross diagonally, posteriorly and superiorly in the sylvian fissure, and are distinguished as (1) the *posterior parietal artery* (Fig. 1 and 2), which supplies the convexity of the parietal lobe, (2) the *angular artery* (Fig. 1 and 2), which supplies the angular gyrus and the parietal-occipital convexity, and (3) the *posterior temporal artery* (Fig. 1 and 2), a vessel which brings blood to the superior and posterior portions of the temporal lobe.

The *vertebral artery* turns behind the superior process of the atlas (Fig. 3), enters the foramen magnum from the ventrolateral aspect of the upper cervical spinal cord, and unites with its fellow from the opposite side at a point on the ventral surface of the medulla oblongata, just below the posterior border of the pons. Before the vertebrals join, they give off two lateral branches (the *posterior spinal arteries*), and a medial branch (the *anterior spinal artery*) and the *posterior inferior cerebellar artery* (Fig. 3). The last named vessel courses dorsolaterally around the medulla oblongata to supply the ventrolateral portion of the cerebellum and medulla. The vertebrals fuse at the pontomedullary junction to form the *basilar artery* (Fig. 3), which runs in the basilar sulcus on the ventral surface of the pons, superior to the clivus, and ends in the interpeduncular fossa. The basilar artery gives off (1) the *anterior inferior cerebellar* arteries, which arise near the posterior border of the pons and pass backward to the under surface of the cerebellum nearest the pons, (2) the *superior cerebellar arteries* (Fig. 1), which arise near the anterior border of the pons and pass dorsally along the anterior edge of the pons to supply the anterior surface of the cerebellum, (3) the *internal auditory arteries* (Fig. 3) which follow the auditory cranial nerves into the internal acoustic meati, (4) numerous twigs to the pons, and (5) its terminal bifurcation—the *posterior cerebral arteries* which are described above.

The *venous return* from the brain is demonstrable with this method by a modification in the timing of roentgenography. The technique is described below. The venous channels can be classified in the following manner:

(1) *Superficial Cerebral Veins*. These vessels collect blood from the convex and medial surfaces of the cortex, and terminate obliquely in the superior longitudinal sinus, or in its venous lacunae. A variable number of roughly parallel superficial veins (*frontal*, *parietal*, and *occipital*), follow the sulci of the brain to the *superior longitudinal sinus* (Fig. 4 and 5). Some of the veins from the convex surface of the occipital lobe go to the transverse sinus. The *middle cerebral vein* (sylvian) (Fig. 5) runs from the lateral aspect of the sylvian fissure around to drain the insula and opercular region. It empties into the *cavernous sinus*. The middle cerebral vein is connected with the transverse sinus by the *posterior anastomotic vein of Labbé* (Fig. 4

and 5) and with the superior longitudinal sinus by the *great anastomotic vein of Trolard* (Fig. 4 and 5).

(2) *Deep Cerebral Veins.* Several deep veins may be distinct. These vessels drain the basal ganglia. Each of the two *internal cerebral veins* (Fig. 4 and 5) begins in the interventricular foramen by the fusion of the chorioidal and terminal veins. Each courses posteriorly in the tela choroidea of the third ventricle and, at a point just behind the pineal gland, join to form the *great cerebral vein of Galen* (Fig. 4 and 5). The vein of Galen also receives the *paired basal veins of Rosenthal* (Fig. 4 and 5), which receive tributaries from the anterior perforated substance, adjacent orbital cortex, interpeduncular region, rip of the temporal horn, insula and operculum, and run posteriorly around the cerebral peduncle in order to drain into the vein of Galen. The basal veins of Rosenthal are not the same as the basilar venous plexus. The great cerebral vein of Galen is median in position, short, and bends dorsally around the splenium of the corpus callosum to empty into the *straight sinus* (Fig. 4 and 5).

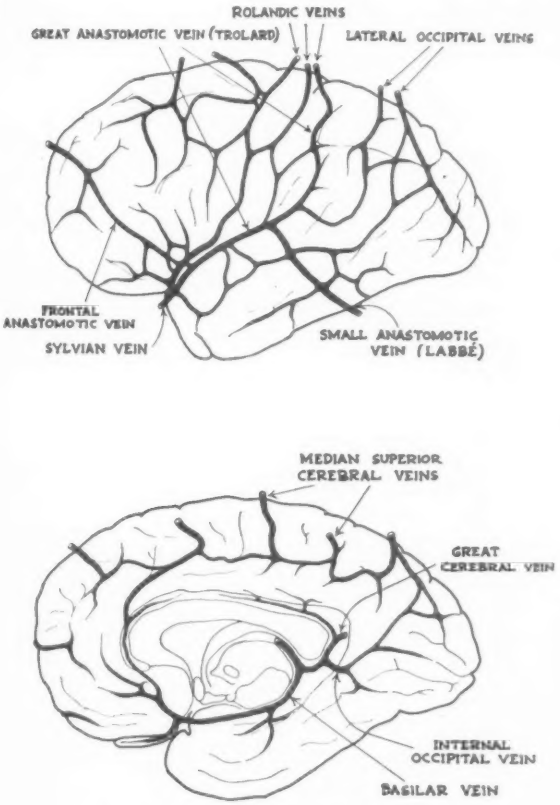

Fig. 4. Veins of the brain (Bailey).

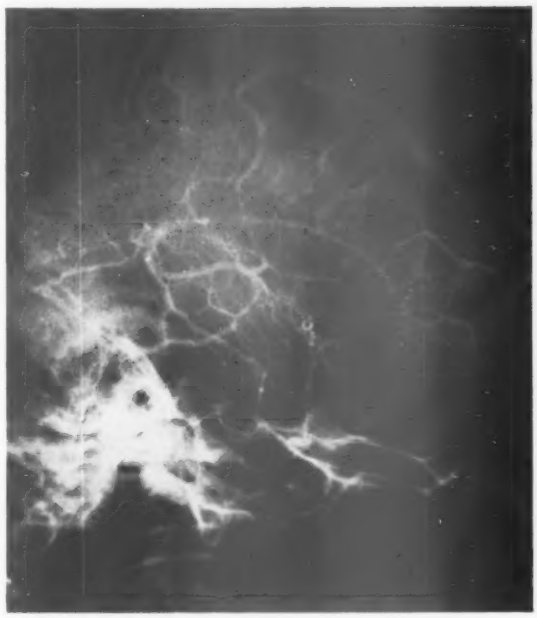

Fig. 5. Normal phlebogram (carotid injection).

(3) *Dural Sinuses.* Phlebographic studies of these structures have less clinical application than examinations of the arteries and veins. The superior longitudinal sinus, straight sinus, and lateral sinuses, join in the torcular Herophili (confluent sinus). The inferior longitudinal sinus fuses with the great vein of Galen and forms the straight sinus. Egas Moniz[12,14] has made the interesting observation that the straight sinus is a direct continuation of the inferior longitudinal sinus and that the great cerebral vein of Galen joins it at an acute angle.

CIRCULATION TIME

It has been observed repeatedly that the normal circulation time of the cerebral blood vessels is approximately four seconds. This represents the time required for blood to pass from the carotid artery and its branches, into the capillary bed, through the cerebral veins, into the dural sinuses. The arterial phase lasts for no more than one second following the completion of the

injection of contrast substance. The capillary phase is usually complete within four to five seconds following the completion of the injection. By proper timing of the roentgenographic exposure and arterial injection, any of these phases of cerebral circulation can be visualized. In examinations in which the external carotid circulation was visualized simultaneously with that of the internal carotid artery, it was observed that the circulation time of the former is one to three seconds slower than the cerebral circulation. This was observed for the first time by Egas Moniz and Alves.[17] The rate of flow through the vertebral system is also slower than through the carotid system.

Normally, the volume and rate of the blood streaming through the brain depend upon: (1) the size of the cerebral vascular bed, and (2) the difference between the arterial and venous pressures. The caliber of the vessels is influenced by the chemical constituents of the blood, vasomotor impulses, and by hydrodynamic factors (blood pressure, venous pressure, and cerebrospinal pressure). Increased intracranial pressure generally decreases the circulation time. Similarly, certain neoplasms, aneurysms and partial vascular occlusions are sometimes observed to slow down the circulation of the contrast substance. We have observed that in the cases where blood and contrast medium were mixed prior to injection poor films resulted because of the dilution of the radiopaque material.

The possible dangers of manipulation and trauma to the carotid sinus are maximal in carotid angiography. It is well known that stimulation of the carotid sinus in certain individuals brings about a retardation of the heart rate and a fall in blood pressure. These changes, in turn, are projected into the vascular system of the brain, causing a cerebral anemia, which is responsible for the clinical symptoms. In his monograph regarding this particular problem, Ask-Upmark[2] states, "The method may have some advantages, but it should immediately be said that besides other dangers, the possibility of an irritation of the carotid sinus is very near at hand." He believes that the dangers are minimized if only the common carotid artery is used for the injection. We have used the common carotid artery routinely as the site of injection, both by direct puncture and by operative exposure and have observed no untoward reactions of this nature.

TECHNIQUES

The purpose of angiography of the brain is to visualize the cerebral vasculature by means of perfusion of the cerebral vessels with harmless radiopaque materials. The vessels which supply the circle of Willis are the internal carotid and vertebral arteries. Accordingly, one of these arterial systems must be injected with the contrast medium. Unfortunately, the perfusion of a single system, carotid or vertebral, does not permit visualization of the entire vasculature of the cerebrum. This is due to the minute structure of the anterior and posterior communicating arteries, which obstruct the passage of the radiopaque material. It would be necessary to inject both carotid arteries and one vertebral artery (either vertebral artery will carry the material to the basilar artery), in order to visualize all the vessels. In general, the one carotid system includes the distribution of the anterior and middle cerebral arteries on the side injected. The posterior cerebral artery of the same side appeared in 34 per cent of our cases. The vertebral system includes the vessels to the posterior fossa and both posterior cerebral arteries.

Angiography can be done following the direct injection of the internal carotid or vertebral arteries, or by the injection of vessels which contribute to these arteries, namely, the common carotid and subclavian arteries, respectively. Our experience, and that of others interested in this subject has to do primarily with carotid angiography. This is due to the fact that the major portion of the brain receives its blood supply from the carotid vessels, and that neuropathologic entities in which angiography is indicated are most frequent in these vascular areas. It has been

our practice to inject the common carotid artery percutaneously. The problems regarding the choice of the vessel (common or internal carotid) and the methods of injection (percutaneous or following operative exposure) are closely related and have been widely discussed. The use of the common carotid artery leads to the visualization of both the external and internal carotid branches (71 per cent of our cases showed the external carotid circulation). We have found no difficulty in the interpretation of the arteriograms made in this manner, in spite of the presence of both intracranial and scalp vessels. Stereoscopic examinations are helpful in this regard. Egas Moniz[2] has published cases (meningiomas) in which the external carotid circulation has rendered significant diagnostic information. Our experiences confirm these observations.

Egas Moniz,[13] in 1931, Loman and Myerson,[44] Shimidzu,[54] Turnbull,[60] and others, have practiced the *percutaneous method* of injection for angiography. Egas Moniz[14] discontinued the use of percutaneous method because he found that less than 50 per cent of the cases could be done in this manner and has been exposing the artery surgically prior to injection. During the past five years at the Illinois Neuropsychiatric Institute, angiographic studies have been made by over ten different operators and teams. It was possible to obtain satisfactory results in 71 per cent of the cases with the percutaneous method. With practice, the efficiency of each operating team improved considerably, so that we believe that an experienced operating team should attain close to 100 per cent. The cases in which the percutaneous method fails are subjected to surgical exposure of the artery, utilizing the same anesthesia.

We have been using general anesthesia. Sodium pentothal has proved to be a satisfactory agent, and minimum quantities (200 to 1,000 mg.) have been adequate when administered by intravenous drip in 0.2 and 0.5 per cent solutions. Endotracheal intubation has been used routinely during the past year as a precaution against the possibility of laryngeal spasm during manipulation in the neck. It is our opinion that this refinement in technique is not essential and complicates an otherwise simple procedure if the intubation is not done with facility.

The patient is placed in a supine position, with his head resting on a Lucite support, slightly hyperextended and placed with the lateral aspect of the skull against a vertical roentgen-ray head unit. We do not consider severe hyperextension of the head necessary, but use one or two pillows beneath the shoulders to aid in the positioning of the patient. The head is fixed against the head table by means of a cloth strap. We have obtained our clearest angiograms when the arterial injection is made on the side nearest the cassette. However, very satisfactory results may be obtained if the injection is made on the opposite side, which is more convenient for some operators.

The neck is shaved. It is then cleansed with 95 per cent alcohol. A nurse assistant opens an autoclaved tray* which is placed on a nearby table. Sterile towels are draped over the chest of the patient in order to provide a convenient area on which to place the sterile syringes and other materials. An assistant then fills three 20 cc. syringes with diodrast (35 per cent) and three 30 cc. syringes with sodium citrate solution and these are placed at either end of the tray. A citrate syringe is then attached to a two-way stop-cock, which, in turn, is fitted to a short length (8 inches) of rubber tubing. The tubing is connected to a No. 17 gauge, short-beveled needle by a small glass adaptor. We have discontinued the use of a three-way stop-cock, with manometric connection, because, in our experience, it occasioned unnecessary technical errors. The system is filled with citrate and is held by a physician assistant

* Trays contain: (1) 3 syringes, 20 cc. Luer-Lok
(2) 4 syringes, 30 cc.
(3) 2 No. 17 gauge, 2½" short-beveled needles
(4) rubber tubing, 8" lengths, 2
(5) 2 two-way stop-cocks and 2 small glass adaptors
(6) sterile towels, 4×4 dressings
(7) 2 small basins.

who stands on the same side as the operator and to his right, if he is right-handed. The surgeon palpates the common carotid artery deep to the anterior border of the sternomastoid muscle along as much of its course as possible. The direction and depth of the vessel is obtained in this manner. The operator takes the needle in his right hand, palpating the vessel with his left, and punctures the skin over the lowest point at which the pulsation is palpable. Low punctures avoid cannulation of the external carotid artery. The needle is directed parallel to the artery and inserted quickly in order to prevent the vessel from rolling away from the point of the needle. We have entered the vessel a number of times with this first maneuver. On several occasions the slow withdrawal of the needle has shown that the artery was transfixed and arterial blood was obtained on readjusting the point of the needle. Venous blood has been obtained on several occasions, but indicates that the needle was too lateral and redirection in a more medial direction enabled us to cannulate the artery. Occasionally, we have found it helpful to strike the anterolateral edge of the body of the sixth cervical vertebra with the point of the needle. This is quite shallow and slow withdrawal of the needle and readjustment of its point in a more superficial plane in the same direction usually meets with success. One can be quite certain of a successful arterial puncture and cannulation if red blood (in contradistinction to the darker venous blood) is seen to surge into the citrate of the glass adaptor and to pulsate into the syringe filled with citrate. The assistant invariably reports that the plunger of the syringe is being forced backward. It is his task to gently force the citrate into the system in order to prevent coagulation of the blood, formation of clots, and obstruction of the needle.

Before elaborating on the technique of the injection of one of the contrast substances and subsequent angiographic studies, mention should be made regarding patients in whom the percutaneous method is difficult. These individuals are usually short and stocky, or have a short, thick neck in which it is impossible to palpate the artery. It is nevertheless possible to cannulate many of these cases, and accordingly, it is our opinion that this simple procedure should be attempted in all cases. In the event that it appears that the arterial cannulation is to be unsuccessful in spite of an adequate trial of the percutaneous method, it is our practice to transfer the patient to the operation room immediately. The carotid artery is then exposed surgically, utilizing the same anesthesia. The surgical technique of the open operation will not be discussed here. It is well described by Egas Moniz,[14,15] Elvidge,[20] List *et al.*,[38] and others.

The method of injection of the contrast material and the roentgen technique are quite similar whether the artery is cannulated percutaneously or after surgical exposure. After making certain that the needle is open and in the artery, the operator must keep his eyes fixed on the needle and all other manipulations are made by an assistant. The stop-cock is turned by the assistant, who then removes the syringe of citrate and attaches the syringe of diodrast (20 cc.). He opens the stop-cock and the arterial blood is observed to pulsate into the syringe. The material is injected quickly and an order is given to expose the film, just as the last drops are leaving the syringe. The stop-cock is turned and the assistant removes the syringe and washes out the system with citrate, while the roentgen-ray technician shifts the roentgen tube, preparatory to making the stereoscopic exposure.* A second injection of diodrast is made and the films are exposed in order to obtain stereoscopic lateral angiograms. The assistant removes the syringe and again irrigates the system with citrate solution,

* *Roentgenologic Technique.*
General Electric head unit, Potter-Bucky grid.
I. Stereoscopic lateral exposures
60–65 kv., 100 ma., 3/10–5/10 second with the tube 36 inches from the cassette.
II. Anteroposterior exposure (seldom necessary when stereoscopic films are made).
75–80 kv., 100 ma., ¾ second, with a 36 inch distance.

while the films are being changed. As the present time we have been unable to obtain phlebograms immediately following the arteriograms because of inability to change our films quickly enough. Accordingly, a third injection has been made. The exposure is made exactly five seconds following the completion of the injection, and has rendered excellent phlebographic studies. The system is then irrigated once more with sodium citrate solution and the needle is withdrawn.

It is very important to have as many exposures as possible during the passage of the contrast material through the vessels of the brain and sinuses. Arteriography alone is adequate in some instances, but we have observed many cases in which the diagnosis was made only by phlebography, or during the capillary phase. During the war it was impossible to obtain proper apparatus for rapid changing of films and the supply of films was very restricted. We are now making and expect soon to have in use a cranial seriograph similar to the one devised by Sanchez-Perez.[53] This simple apparatus will allow three exposures at one and a half second intervals following an injection and will make a third injection, which we are now using for the phlebogram, unnecessary.

The after-care of these patients is quite simple if the percutaneous method has been employed. All that is required is a tight pressure dressing and the patient may be ambulant as soon as he regains consciousness, if his general condition does not prevent it. We have had no subcutaneous hematomas of significance with the percutaneous procedure. Angiography can be repeated with impunity if operative exposure has not been necessary. The after-care of patients in whom the artery has been exposed surgically is more important. Bed rest for two days, a pressure dressing, and the use of a sand-bag are necessary, in our experience, to prevent alarming hematomas. In the event one desires to repeat the angiography at a later date, it is rendered more difficult by the surgical wound.

The time element is an additional factor which has encouraged us to practice the percutaneous method of angiography. It is possible in many instances to anesthetize the patient and to complete the entire procedure in twenty to twenty-five minutes. We have been unable to duplicate this time with surgical exposure of the artery.

CONTRAST SUBSTANCES

At the present time, four materials are reported to be satisfactory as contrast media for cerebral angiography: (1) thorotrast, (2) diodrast, (3) perabrodil, and (4) ethyl tri-iodine stearate. None of these preparations satisfies all of the criteria of an ideal radiopaque substance (i.e., inert, clearly visualized, non-toxic, non-irritating, rapidly excreted, and inexpensive). Notwithstanding, they all have been used in large series of patients with good results, low morbidity, and virtually no mortality.

1. *Thorotrast.* Thorotrast is a stabilized solution of thorium dioxide (ThO^2) containing 25 per cent by volume and 19–20 per cent by weight, and about the same amount of protective colloid (16–19 per cent) by weight, which is said to be a dextrin preparation. It contains 0.15 per cent methyl p-hydroxy benzoate as a preservative.[5]

Egas Moniz,[13] dissatisfied with the complications resulting from 70 per cent strontium bromide or 25 per cent sodium iodide, began using thorotrast in 1931. As soon as it was apparent that this substance was well tolerated, angiography became popular for the first time.

The particles of thorium dioxide are small enough to pass through the finer vessels, as no reports have been found of embolic phenomena with thorotrast.[5] That particles do remain in some cases was demonstrated in perivascular macrophages in the brain by Northfield and Russell.[46] They reported cases in which they attributed aggravation of neurologic symptoms to thorotrast.

Thorotrast is gradually taken up by the cells of the reticulo-endothelial system

(liver, spleen, lymphoid tissue, bone marrow and, to a lesser extent, by the ovary and suprarenal gland), following its introduction into the vascular system. The liver gets rid of portions of its quota, partly at least, by cellular transport to the lungs and elimination in mucus of the bronchi (Irwin[33]).

The radioactivity of thorotrast has been determined as follows:[5] (a) alpha rays: 25 cc. of thorotrast is the equivalent of 0.5–1.0 microgram of radium, (2) beta rays: of no significance, and (3) gamma rays: of no significance. This amount of radioactivity is almost negligible. However, if larger doses are administered (75 cc. thorotrast is the equivalent of over 3 micrograms of radium), potential dangers from radioactivity become more real. One of our patients developed a transient hemorrhagic tendency following angiography with thorotrast. Otherwise, critical analysis of our patients indicated no difficulties resulting from the substance. Egas Moniz has reported over 1,098 angiographic patients without important sequelae.

The outstanding advantage of thorotrast over all other radiopaque substances which have been developed to date is the painlessness of its injection. It is well tolerated by patients under local anesthesia. The clarity of visualization is also notable, creating no visible reaction during its use. In our opinion, thorotrast is a satisfactory contrast substance for cerebral angiography. We are now using diodrast, however, because of advantages described below.

2. *Diodrast.* Diodrast is 3,5-diiodo-4-pyridone-N-acetic acid and diethanolamine, containing about 50 per cent iodine in firm combination. Several concentrations are available, and the one best suited to cerebral angiography is the sterile aqueous solution, 35 per cent (weight/volume). Diodrast is excreted quite rapidly by the kidneys.

Gross[28] was the first to use diodrast in cerebral angiography, applying a contrast substance already in use by urologists. There are several disturbing features regarding diodrast: (1) it is an iodized solution to which some patients are allergic, (2) it is painful when used with local anesthesia, and (3) it creates a momentary respiratory arrest, associated with movement, which occasionally spoils the angiogram.

We test all patients for sensitivity to diodrast routinely, by a sublingual test (Dolan[9]). Two cubic centimeters of diodrast is placed under the tongue and the patient is instructed to hold it for ten minutes; if no reaction occurs, he is instructed to swallow the material. Sensitivity to diodrast is manifested by a sensation of numbness about the lips and face accompanied by swelling of the tongue. We have observed four moderately severe allergic reactions in patients previously tested with diodrast.

The outstanding advantages of diodrast over thorotrast are that it is excreted and has no potential danger from radioactivity. It can be used with comparative safety in repeated examinations. Allergic reactions may occur with this substance in spite of all precautions. The injection of diodrast is painful and usually requires general anesthesia and sometimes produces movement of the head at the moment of the angiogram. In our opinion, diodrast is a satisfactory contrast substance for cerebral angiography and is preferable to thorotrast because it is just as radiopaque, is excreted, and may be used repeatedly in the same individual.

3. *Perabrodil*[21] and *Ethyl tri-iodine stearate.*[30] These substances are being used in European clinics in addition to thorotrast with good results being reported. We have had no experience with either material.

I. DISEASES OF BLOOD VESSELS

It is well recognized that angiography offers a most specific method of diagnosis in this group of entities. Before Egas Moniz,[12,14] such lesions were diagnosed chiefly according to their clinical symptoms. Egas Moniz made the first angiographic diagnosis of a cerebral aneurysm.

At the present time, angiography is utilized in the major neurological clinics of America almost solely for the diagnosis of vascular pathology (Elvidge,[20] Turnbull,[60] Gross,[28] Fincher,[22] Peet and List,[48] List, Burge and Hodges,[38] List and Hodges,[39] Asenjo and Uiberall,[1] Govons and Grant,[26] and others). Notable European contributors include Dott,[10] Jefferson,[34,35] Tönnis,[57] Sjöqvist,[55] Krayenbühl,[36] Löhr,[41] Bergstrand, Olivecrona and Tönnis,[4] and others). Our material contains 18 cases showing: A. Arterial aneurysms; B. Vascular malformations and tumors, and C. Vascular occlusions.

A. *Saccular Arterial Aneurysms*—11 cases.

TABLE I

CLINICAL ANALYSIS OF 107 ANGIOGRAPHIC EXAMINATIONS

Mortality	0	
Morbidity		
Aggravation of symptoms, allergic reactions—all transient	6	
I. Diseases of Blood Vessels		18 cases
A. Saccular arterial aneurysms	11	
B. Malformations and tumors		
1. Arterial angiomas	2	
2. Venous angioma (Sturge-Weber)	1	
3. Lindau's disease	1	
C. Occlusions		
1. Traumatic	1	
2. Embolic	1	
3. Eclamptic	1	
II. Neoplasms		58 cases
A. Meningiomas	7	
B. Sarcoma of meninges	2	
C. Gliomas		
1. Astrocytomas	4	
2. Glioblastoma multiforme	28	
3. Miscellaneous		
Subependymal plate	1	
3rd ventricle	1	
D. Cancer metastases	7	
E. Unverified tumors of the brain	8	
III. Miscellaneous Conditions		5 cases
A. Subdural hematoma	1	
B. Brain abscess	1	
C. Others	3	
IV. Normal Angiograms		26 cases

FIG. 6. Case 1. Saccular aneurysm of internal carotid artery.

All of our patients, in whom arterial aneurysms were demonstrated by this method, showed saccular enlargements. Such abnormalities are usually of (1) congenital, (2) arteriosclerotic, or (3) mycotic origin. Although the saccular aneurysm is most frequently found in the "carotid siphon" or on a vessel of the circle of Willis, multiple aneurysms are not infrequent. Dandy[7] reported 108 cases with 133 aneurysms. If multiple aneurysms are suspected, bilateral angiography is essential (Egas Moniz,[14] Penfield,[49] and others). The small saccular aneurysms which are situated on the carotid siphon most commonly arise from the distal portion, just proximal to the posterior communicating artery, and tend to affect the oculomotor nerve (Egas Moniz,[12,14] Dott,[10] and Olivecrona[47]). Seven of our saccular aneurysms were of this type. In Dandy's series,[7] 44 per cent of the 133 aneurysms were located on the internal carotid artery, 19.5 per cent on the middle cerebral artery, 19.5 per cent in the anterior cerebral or anterior communicating arteries, no aneurysms on the posterior communicating artery, and 19 per cent on the basilar, vertebral or posterior cerebral arteries. The following case illustrates the the common type of saccular aneurysm (Fig. 6).

CASE 1.

History. D. D. (No. 91791), a housewife, white, aged forty-three, was admitted on November 16, 1943, because of an acute onset of headache, motor aphasia and right hemiparesis of one week's duration.

Examination. Lethargy, motor aphasia, oculomotor palsy on the left, no nuchal rigidity, right homonymous hemianopsia, Babinski sign and absence of abdominal reflexes on the right side.

Lumbar Puncture. Initial pressure, 150 mm. water; xanthochromic fluid.

Roentgenograms. Skull and chest, normal.

Tentative Diagnosis. Ruptured aneurysm, internal carotid artery, left.

Treatment. Bed rest for six weeks, with good response.

Angiography. The left common carotid artery was injected percutaneously with diodrast. Sodium pentothal anesthesia was administered without endotracheal intubation. The external and internal carotid arteries were visualized. The carotid siphon, anterior and middle cerebral arteries appeared to be normal. A saccular enlargement was seen arising from the posterior part of the carotid siphon just proximal to the origin of its terminal branches (Fig. 6).

Course. She resumed ambulation the following day and complained only of minor tenderness of the neck. Conservative therapy was decided upon and the patient was discharged on January 10, 1944.

Comment. Saccular aneurysms comprised the majority of our vascular anomalies. Arterial aneurysms are usually (1) congenital, (2) arteriosclerotic, or (3) mycotic in origin. In no case was there aggravation of the symptoms or signs due to angiography.

Arterial aneurysms of the cerebral vessels may be intradural or extradural. The intradural aneurysms are usually of congenital origin. The embryological aspects of their formation is discussed below. They appear as small berry-like sacculations in the angiogram and tend to rupture before becoming large. Accordingly, intradural aneurysms are silent clinically until they leak into the subarachnoid space. Extradural aneurysms of the internal carotid artery are usually of arteriosclerotic origin and are located within the cavernous sinus. They rarely rupture, but enlarge to simulate a neoplasm. They frequently calcify. We had no such example. Angiography is the procedure of choice in the diagnosis of such extradural, subclinoid abnormalities, and offers a clear differentiation between parasellar neoplasm and aneurysm (Hermann, Obrador and Dott,[32] and List and Hodges[39]).

We have been impressed with a group of patients in whom the clinical diagnosis of aneurysm seemed to be certain but could not be verified by any abnormality in the angiogram. It has been pointed out that such instances may occur if the aneurysm or its neck is too small to receive the contrast substance, or if the aneurysm is filled with hematoma (List and Hodges[39]). In such cases the neurosurgeon must decide on the method of therapy without the benefit of angiography. Fortunately, the aneurysm can usually be visualized by angiography and its exact site, size and anatomical relationships are determined prior to the institution of treatment. This knowledge is of invaluable aid to the operator in planning whether to merely ligate the internal carotid artery in the neck or to make an intracranial exploration in an attempt to "trap the aneurysm." Procedures following craniotomy include: (1) ligation of the affected vessel, with or without extirpation of the aneurysm, and (2) the compression of the aneurysm with muscle stamps within or around its sac. Any of these procedures is fraught with great hazards. The patient's prognosis, however, ordinarily demands desperate measures, because recurrence of subarachnoid hemorrhage from rupture of the aneurysm is almost certain and may be fatal.

If the angiogram demonstrates an aneurysm to be located below the terminal bifurcation of the internal carotid artery (i.e., on the "carotid siphon" or below (Fig. 7*A*)), thrombosis of the aneurysmal sac can be effected by ligation of the internal carotid artery in the neck. It has been emphasized (Hermann, Obrador and Dott[32]) that this ligation should be delayed, if the

angiogram shows compression of the local blood supply by clot, until circulation has become re-established.

If the angiogram demonstrates an aneurysm to be located above the terminal bifurcation of the internal carotid artery (i.e., on the middle or anterior cerebral arteries), intracranial ligation must be done

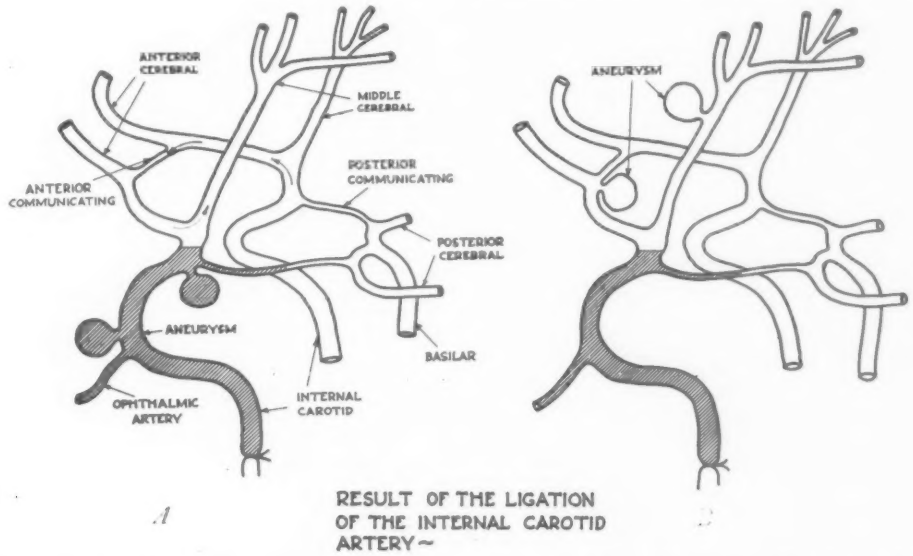

FIG. 7. Result of ligation of the internal carotid artery (modified from Hermann, Obrador and Dott).[32]

in order to create thrombosis of the aneurysmal sac (Fig. 7*B*).

B. *Vascular Malformations and Tumors.* Malformations and tumors arising from cerebral vessels are relatively rare. They comprised no more than 2 per cent of 2,023 cerebral lesions reported by Cushing and Bailey[6] and are classified as follows:

I. Angiomatous malformations
   A. Telangiectases
   B. Venous angiomas
   C. Arterial angiomas
II. Hemangioblastomas—cerebellar and cerebral (Lindau tumor)

Our series of angiographic examinations contained examples of each variety except telangiectases.

The significance of the embryological concept in the understanding of these lesions has been emphasized by Cushing and Bailey.[6] The development of the vascular system of the head was elucidated especially by Sabin[52] and Streeter.[56] Streeter has pointed out five arbitrary successive stages of development:

I. Establishment of primordial vascular system of the head (angioblasts differentiate into a germinal bed of endothelium): It is seen from Sabin's work[52] that the hemangioblastomas probably occur during this stage, because of failure in the normal development or because of displacement of a group of angioblasts.

II. Differentiation of the primordial system into arteries, veins and capillaries: If certain areas of the original plexiform system fail to develop, the resulting vessels may become unrecognizable due to their unusual structure and communications. Hemangioblastomas may occur at this stage, and especially cavernous angiomas or mixed racemose angiomas.

III. Cleavage of the blood vessels of the head into separate systems: This corresponds to the development of the membranous skull, dura mater and pia-arachnoid. Sturge-Weber disease and its variants result from embryological arrest of a portion of the vascular system of the head at this stage.

IV. Adjustments of blood channels due to growth and changes in from the brain

and ear: Abnormalities at this stage may cause gross abnormalities in the course of the vascular trunks.

V. Completion of the histological differentiation of the walls of the blood vessels: Saccular aneurysms are considered to result from the lack of muscular layer of the wall of a vessel at a point of bifurcation. This abnormality probably occurs during this final stage of embryological development of the vascular system of the head.

The following cases illustrate vascular malformations occurring at various embryologic levels.

CASE II.

History. H. Y. (No. 106623), a white male, aged twenty-three, became giddy and then

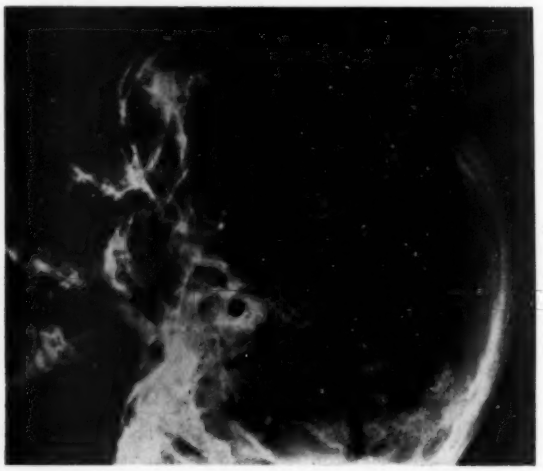

FIG. 8. Case II. Arteriovenous angioma of rolandic area.

unconscious in October, 1944. He remained unconscious for forty-eight hours and on recovering consciousness it was found that he retained a marked right hemiparesis, diplopia, and ideomotor aphasia. He gradually improved and was admitted May 14, 1946. The right hemiparesis was found to be most marked in the lower extremities. A tentative diagnosis of "congenital aneurysm, left internal carotid artery" was made and observation in the Out-patient Department decided upon. Jacksonian motor seizures began in July, 1946, affecting the right hand and arm, followed by a generalized seizure and unconsciousness. He was re-admitted.

Examination. Nystagmoid movements, right hemiparesis.

Laboratory. Blood counts, serology, chemistry and urine studies were normal.

Roentgenograms. Skull and chest, normal.

Angiography (June 1, 1946). The left common carotid artery was injected percutaneously. Sodium pentothal anesthesia was administered with endotracheal intubation. The external and internal carotid arteries were visualized (Fig. 8). A tangle, approximately 3 cm. in diameter, of large and small blood vessels, appeared in the rolandic area on the left side near the vertex. This malformation was seen to receive the major portion of its blood supply from a very dilated and tortuous anterior cerebral artery. Both external and middle cerebral arteries contributed tortuous, dilated vessels to the same area. The malformation was seen to drain into the superior longitudinal sinus.

Course. Procedure tolerated well and symptoms not aggravated or benefited. Discharged to attend to business affairs.

Re-admission and Craniotomy. A large frontoparietal osteoplastic craniotomy was done on August 15, 1946, by Dr. Milton Tinsley. The vascular malformation was exposed, but deemed inoperable.

Course. Good postoperative recovery without change in neurologic status. Discharged, August 28, 1946.

CASE III.

History. C. M. (No. 95747), a white female, aged thirty-seven, was admitted August 8, 1944, because of (1) severe headaches of two and one-half years' duration, and (2) failing vision of the right eye for three years. The symptoms were progressive and were associated with vomiting for three weeks prior to admission.

Examination. Acutely ill; bilateral papilledema with secondary optic atrophy, right temporal hemianopsia, light perception only on the left side, "port-wine mark" of right forehead, generalized bruit which was not changed by compression of either carotid artery, and hyper-reflexia.

Roentgenograms. Skull—absence of clinoid processes, secondary to chronic increased intracranial pressure.

Cerebrospinal Fluid. Pressure in lumbar subarachnoid space: 300 mm. water, normal analysis.

Seizures. Motor, beginning on the right side, during hospital observation.

Subtemporal Decompression (September 20,

1944). A right subtemporal decompression was done as a palliative procedure. Tortuous cortical veins and considerable pressure were encountered.

Angiography (October 5, 1944). The left common carotid artery was injected percutaneously. Sodium pentothal anesthesia was administered with endotracheal intubation. The floor of the anterior fossa and supraclinoid region was masked by a large cluster of dilated vessels (Fig. 9). The internal carotid artery appeared to be dilated and tortuous in its course through the carotid canal and parasellar region. It entered the large cirsoid anomaly directly. Several dilated serpentine venous channels emerged from the frontopolar aspect of this malformation to empty into the anterior portion of the superior longitudinal sinus. The sinus showed evidence of filling during the arterial phase of angiography. A dilated coil passed from the posterior aspect of the suprasellar anomaly to an enlarged straight sinus (Fig. 9*B*). Serpentine venous channels passed from the convexity to the superior longitudinal sinus and were best seen in the usual exposure for phlebograms (Fig. 9*C*).

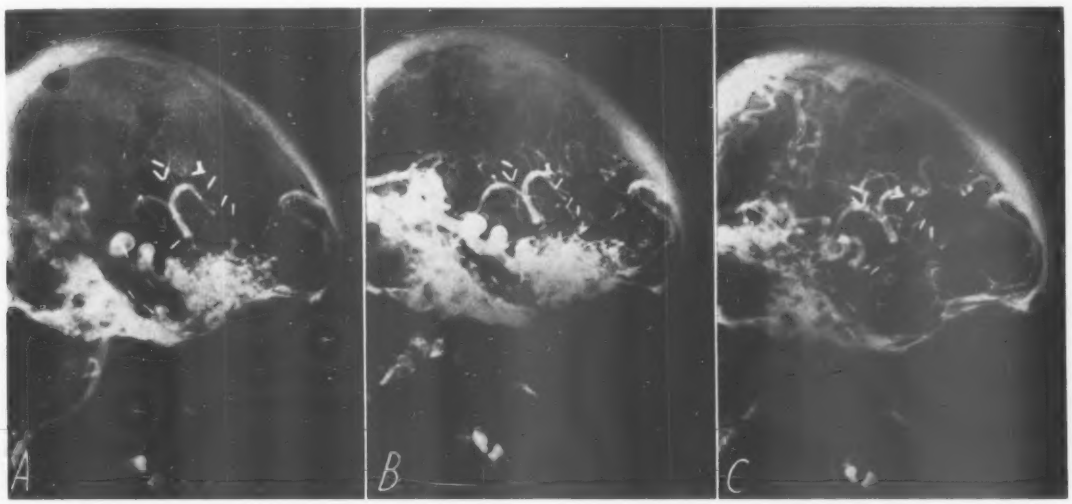

Fig. 9. Case III. Racemose arteriovenous aneurysm of cribriform area and associated vascular anomalies. *A*, arterial phase. *B*, capillary phase. *C*, venous phase.

Course. The procedure was well tolerated. However, the intracranial pressure could not be controlled and she gradually became comatose, and died on November 20, 1944 (six weeks following angiography).

Necropsy. On external inspection one sees, on the dorsal surface, that the superior cerebral veins are vastly dilated, from the frontal pole to the occipital pole. The superior cerebral veins go directly across the sinus posteriorly. On the under surface of the brain is seen, on the orbital surface of the left frontal lobe, a tangled mass of blood vessels which appear to be mainly veins and running out from them large venous trunks—in the sylvian fissure, over the tip of the frontal pole and over the tip of the temporal pole, also down around the tuber, posteriorly. This tangled mass of veins extends also onto the medial surface of the frontal pole. The principal anomaly, therefore, lies on the orbital surface of the frontal pole, involving the area of the anterior cerebral artery.

On detaching the cerebellum from the cerebral hemispheres, at the cerebral peduncles, one sees large tortuous veins on the superior surface of the cerebellar hemispheres. Horizontal section made through the cerebral hemispheres demonstrates the abnormal blood vessels extending deep into the left frontal pole, mainly on the medial surface, and also dilated blood vessels in the medial portion of the occipital lobe as well.

Case IV.

History. J. W. (No. 90248), a boy, aged three, was admitted July 30, 1943, because of unmanageable motor seizures, beginning in the left hand. He had been born with a large "port-wine birthmark" of the skin in the area of distribution of the ophthalmic and maxillary divi-

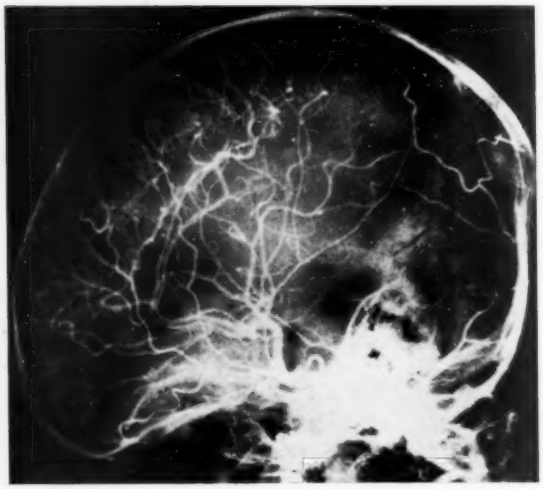

FIG. 10. Case IV. Sturge-Weber disease.

sions of the right trigeminal nerve. He developed slowly and his family noted mental retardation and paucity of movements of the left side of his body.

Examination. Mental retardation, "port-wine birthmark," left hemiatrophy, mild left hemiparesis, and pes planus on the left side.

Roentgenograms. Skull, chest and abdomen were normal, except for (1) asymmetry of skull (left larger) and, (2) sinuous, double-contoured calcifications in the right parietal lobe, 2 cm. from the midline.

Electroencephalography. Slow wave focus in posterior parietal region on right side.

Pneumoencephalography. Cortical atrophy of right cerebral hemisphere.

Angiography (August 14, 1943). The right common carotid artery was perfused (percutaneous method) with diodrast, utilizing ether anesthesia. The external and internal carotid arteries were well visualized on the right side (Fig. 10). Both anterior cerebral arteries filled. The right pericallosal was displaced superiorly in the posterior aspect of its course, beginning at a point near the mid-portion of the body of the corpus callosum. There was a marked increase in vascularity and an abnormal tangle of blood vessels in the peripheral distribution of the posterior portion of the pericallosal artery of the rght side. The area of calcification was seen to be incorporated anteriorly in the peripheral capillary loops of the superior parietal branches. Most of the terminal distribution of the posterior parietal artery was also involved in a tangle of abnormal blood vessels of small caliber and in one portion appeared to be incorporated in the calcified area. The right postcentral region, near the vertex (area near the calcification) still contained diodrast after the peripheral branches elsewhere had emptied.

Extirpation of Calcified Cortex (August 28, 1943). Histopathologic studies were made.

Course. Good convalescence; no seizures for six months, but subsequent correspondence has not been answered.

Comment. This case has been recorded in detail by one of us (J.R.G.[27]). "The diagnosis of angiomatous malformations of the brain may be suspected if a child is born with a 'port-wine birthmark' in the area of supply of the trigeminal nerve, or has a congenital glaucoma and subsequently develops convulsions. The roentgenologic appearance of intracranial calcifications is typical and pathognomonic, when present. Pneumoencephalography and electroencephalography may lend contributory evidence. In our opinion, the diagnosis may be confirmed if satisfactory stereoscopic angiographic studies can be made, even when calcifications are absent."[27]

This child was our youngest candidate for angiography and tolerated the procedure in excellent fashion.

CASE V.

History. W. P. (No. 104842), a housewife, aged thirty-eight, was admitted on May 13, 1946, because of generalized convulsive seizures. Visual loss began in 1929, and was complete within one year. This was caused by retinal detachments, secondary to angiomatosis retinae. She was well until 1939, when she developed headaches, vomiting, and asynergia. Suboccipital craniotomy revealed a large cystic tumor which was drained. The postoperative convalescence was uneventful and she resumed her study of Braille. Convulsive seizures, beginning in the right upper extremity commenced in March 1946, and became unmanageable.

Examination. Ambulant; blind; previous operative scars; otherwise normal findings. Roentgenologic studies (skull, chest, intravenous pyelography, and gastrointestinal roentgenoscopy) were normal, except for the operative defects in the skull.

Electroencephalography. Slow wave focus in the left occipital area.

Angiography (May 23, 1946). The left common carotid artery was injected percutaneously utilizing sodium pentothal anesthesia. The external and internal carotid arteries were visualized (Fig. 11). Craniotomy defects were noted in the posterior parietal and suboccipital regions. The anterior, middle and posterior cerebral arteries were clearly demarcated on the left side. Two abnormalities could be seen: (1) a pea-sized area of increased density in the superior portion of the left rolandic area in relation to the artery, and (2) a number of tortuous vascular channels and nets in the occipital region at the termination of the posterior cerebral artery.

Course. The patient experienced no reaction from the procedure, other than the usual tenderness at the site of puncture for the first twenty-four hours. She was ambulant the following day. It was decided to treat the vascular anomaly in the rolandic area conservatively and the patient was discharged, and has subsequently been controlled by medication.

Comment. Lindau's disease is rare. The association of angiomatosis retinae (von Hippel's disease) and cystic tumor of the cerebellum (and occasionally of the pancreas, liver and kidney) was first made in 1926 (Lindau[37]). It is our opinion that the vascular pathology visualized in the rolandic area of this patient is a small capillary hemangioblastoma. A thorough search of the angiographic literature failed to reveal a similar case. We regret not having a visualization of the cerebellar tumor.

C. Vascular Occlusions.

Neurologists are constantly required to make a differentiation of the causes of a focal lesion of the cerebrum. It is frequently very difficult to decide whether a middle-aged patient with moderate hypertension has a neoplasm or some vascular lesion of the brain, because (1) the onset of symptoms may be sudden and the course rapid in both conditions, or (2) the syndrome may be insidious in onset in either instance. Angiography frequently affords a specific type of diagnosis in such cases. It should be emphasized that this diagnostic procedure should be limited in its use in cerebral arteriosclerosis to those patients exhibiting

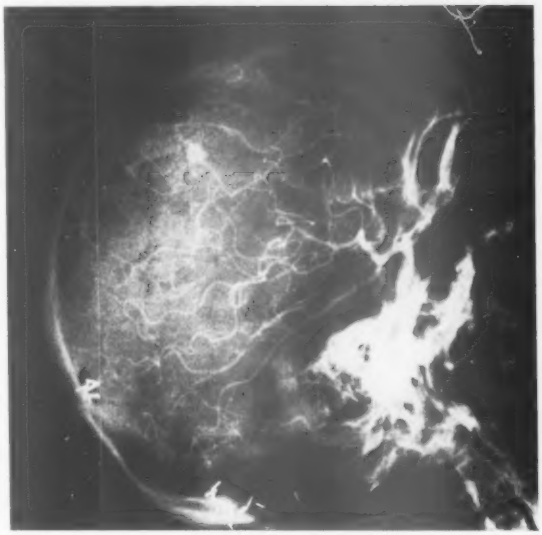

Fig. 11. Case v. Capillary hemangioblastoma of rolandic area. Note cerebellar defect. Lindau's disease.

symptoms and signs of neoplasm. In the younger age groups, angiography may be used to determine the etiology of focal lesions, with less hesitation if the diagnosis cannot be established by other means. The following case report illustrates the value of such a diagnostic method.

Case vi.

History. F. R. No. 109833), a forty-two year old white female tavern keeper, was admitted on February 10, 1947, as a brain tumor suspect. Right hemiparesis and motor aphasia began in October, 1945. She improved within two months after the onset and was able to resume her occupation. Following a blow on the head, in December, 1946, she sustained memory loss and motor aphasia, which did not improve up to the time of hospitalization.

Examination. Obese; ideomotor aphasia, memory deficit; mild right hemiparesis; mitral heart disease; positive Rumpel-Leeds test; recent epistaxis.

Blood Counts, Serology and Sedimentation Rate. Normal.

Roentgenograms. Skull, normal. The chest film showed prominence of the pulmonary conus and of the left border of the heart.

Electroencephalography. Normal.

Lumbar Puncture. Initial pressure of 230 mm. water, normal analysis.

Angiography. The left common carotid artery

was injected percutaneously with thorotrast and diodrast. Sodium pentothal anesthesia was administered with endotracheal intubation. The angiograms showed (1) complete occlusion of the left middle cerebral artery at its origin from the internal carotid artery, (2) slight dilatation and unusual filling of the anterior and posterior cerebral arteries, arterioles and capillaries, indicating collateral circulation.

Course. She experienced no unusual reaction from the procedure and was ambulant the following day. On discharge the second postoperative day, she was able to pronounce her own name and to speak moderately well. Discharge diagnosis: Occlusion, left middle cerebral artery, secondary to embolism from rheumatic heart.

Comment. Improvement, both objectively and subjectively, following angiography has been observed in 2 additional patients in our series. Egas Moniz,[14] Engeset,[21] and others, have remarked about this phenomenon, and we were unwilling to accept their observations until verified by such experiences as we have cited above. The procedure should certainly not be recommended to any patient as a therapeutic measure.

We have had no case of thrombosis of the internal carotid artery below the level of the "siphon," as described by Egas Moniz[14,16] and Löhr and Reichert.[43]

It is of interest to note that a number of our cases with severe hemiplegia and aphasia showed no occlusion of the major trunks or branches of the middle cerebral artery. Although these angiograms are classified as normal, it is our opinion that vascular occlusion has occurred in the perforating branches to the internal capsule. A "normal" angiography in such cases is particularly of value in ruling out the presence of a neoplasm, abscess, or vascular anomaly. Vascular occlusions secondary to neoplasms and trauma are discussed in subsequent paragraphs.

II. NEOPLASMS

It is surprising to find few reports regarding the angiographic diagnosis of cerebral tumor in the American literature (Gross,[28] Peet and List,[48] and Freeman *et al.*[24]). This situation is probably the result of (1) satisfaction with existing methods, including air studies, and (2) lack of information and experience concerning the values and dangers of angiography.*

Neoplasms produce definite angiographic alterations: (1) displacement of normal vessels, (2) pathological changes within the blood vessels of certain tumors, and (3) dilatation of vessels supplying a tumor, i.e., meningiomas. Angiography, therefore, offers not only an anatomic localization of the neoplasm (like ventriculography), but also a histopathologic type diagnosis in the majority of instances. This information is of considerable neurosurgical importance.

The first angiographic studies of cerebral tumors were made by Egas Moniz[12] in 1927. Egas Moniz, Pinto and Almeida Lima[18] described meningiomas in 1929. Löhr and Reichert[43] supplemented these findings, emphasizing the localization of tumors of the temporal lobe. The angiographic characteristics of glioblastoma multiforme were elucidated by Tönnis.[58] European contributions have stressed not only *localization* (Dyes,[11] Engeset,[21] and others) but also the *pathologic diagnosis* (Fischer,[23] Lorenz,[45] Hemmingson,[31] and others) of brain tumors by this method.

Our angiographic material contained 58 patients with neoplasms. The majority of these patients had increased intracranial pressure. According to Peet and List,[48] "Angiography appears to be safer than ventriculography in hemispheral tumors with high intracranial pressure, because the procedure does not interfere with the intracranial hydro-dynamics." Except for one patient, who was done early in the series and died as the result of pneumonia due to aspiration of gastric contents during anesthesia, we found no instance of aggravation of symptoms or signs and no deaths in this group of cases. Guttmann[29] concludes that

* An excellent study has appeared while our report was in press: List, C. F., and Hodges, F. J. Differential diagnosis of intra-cranial neoplasms by cerebral angiography. *Radiology*, 1947, *48*, 493–508.

angiography is less dangerous than ventriculography. It has another advantage in that it is not necessary to follow the procedure immediately with craniotomy. Both procedures are certainly valuable as diagnostic aids and each has its particular field of usefulness.

A. *Cerebral Localization by Angiography.* The sylvian vessels are of great value as anatomic landmarks in the localization of cerebral neoplasms. Tumors which are located below the sylvian fissure are ideally situated for localization by angiography. In temporal lobe tumors the entire middle cerebral artery, in its proximal and distal portions, is elevated. In parietal and occipital lobe tumors, which also lift the sylvian groups of vessels, careful stereoscopic examination of the lateral projection, or an anteroposterior projection, demonstrates that the proximal portion of the middle cerebral artery is not affected, but that its distal part is elevated by the neoplasm.

Frontoparietal tumors above the sylvian fissure are easily localized by means of displacement of adjacent vessels and the information so obtained is usually an adequate basis for craniotomy. This also obtains for parietal lobe tumors which are located behind the sylvian fissure. Deep medially placed frontoparietal neoplasms create only slight changes in the major vessels with only minor straightening of the side branches of the sylvian vessels. This group of lesions usually requires additional study for localization, including ventriculography.

Frontal lobe tumors can usually be localized by means of stereoscopic lateral angiograms. If the lesion is placed posteriorly, the sylvian group of vessels will be displaced downward, and the posterior portion of the pericallosal artery may be elevated (the medial vessels are usually unaffected). Deep frontal tumors, third ventricle tumors, and hydrocephalus can cause elevation and tightening of the pericallosal artery, stretching of the vessels in the frontoparietal regions, and stretching or slight depression of the sylvian vessels.

Fischer[23] has stressed positive and negative *frontopolar signs*. A negative sign indicates a tumor of the pole of the frontal lobe and is characterized by a lateral displacement of the anterior cerebral artery, which forms a smooth arc to one side (both the anterior cerebral artery and its frontopolar branch). A positive sign indicates a posterior frontal tumor and is characterized by displacement of the anterior cerebral artery, thereby forming a point toward the normal side, corresponding to the point of origin of the frontopolar artery. In this instance, the frontopolar artery, which is attached polarly, remains in place, drawing out the anterior cerebral artery to a point, where it is attached.

Midline tumors (above the ventricular system) always create displacement of the anterior cerebral artery or show vascularization from this artery. The sylvian vessels are occasionally involved. Stereoscopic laterals or an anteroposterior projection is essential to show lateral displacement of the anterior cerebral artery or elevation of the carotid siphon, and the anterior cerebral artery.

Neoplasms of the third ventricle, quadrigeminal plate, and posterior fossa are best localized by clinical acumen and ventriculography.

B. *Neoplastic Type Diagnosis by Angiography.*

A primary concept in the diagnosis of cerebral neoplasms by angiography is an understanding of the histopathologic variants and gradients of the various tumor types. The clinicopathologic relationship of these cerebral tumors has been emphasized by Bailey.[3] It follows that the angiographic method will also show many variants among the meningiomas, gliomas, and other cerebral neoplasms. Each neoplasm has definite characteristics, and the following cases are representative of the common types observed in our series.

1. *Meningiomas.* An important characteristic of these neoplasms is that they

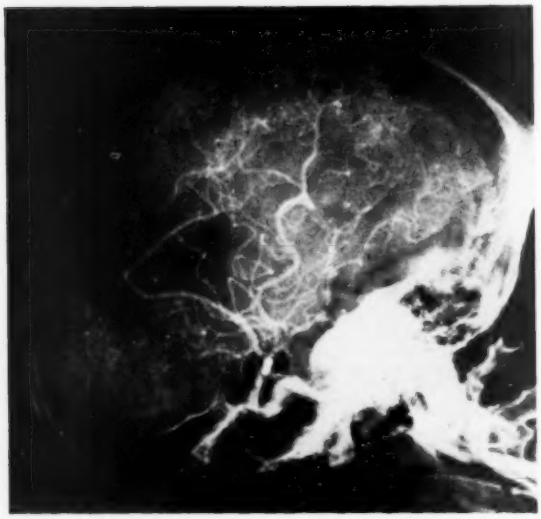

FIG. 12. Case VII. Meningioma, cribriform plate (verified).

nearly always derive much of their blood supply from the external carotid artery in contradistinction to the gliomas which receive no blood from this source. Accordingly, a neoplasm which obtains its blood from both the internal and external carotid arteries is most probably a meningioma and not a glioma. This indicates the necessity of injecting the common carotid artery in the angiography of neoplasms. If the external carotid artery is found to contribute blood to a tumor it is sometimes important to ligate the artery prior to craniotomy, as emphasized by Reichert.[50]

Angiographic characteristics of meningiomas (modified from Lorenz[45]):

1. It is possible to distinguish vascular structures which supply the tumor and those displaced by or surrounding it (this does not obtain in vascular malformations).

2. The afferent vessels of the tumor branch into it in a reticular formation.

3. Newly formed vessels may be seen in a meningioma, but are sharply defined and well saturated with contrast substance, showing no arteriovenous connections, in contrast to those seen in the glioblastoma multiforme.

4. The external carotid artery frequently is seen to contribute blood vessels to the tumor.

We have had 7 meningiomas of 58 neoplasms studied angiographically.

CASE VII.

History. L. L. (No. 107870), a white male, aged sixty-four, was admitted October 20, 1946, because of gradual blindness of the left eye and partial blindness of the right eye. His family reported bizarre personality changes.

Examination. Mild euphoria; anosmia; no light perception and optic atrophy on the left and retention of the inferior nasal visual field on the right.

Roentgenograms. Skull and chest, normal, except for a few, very fine flecks of calcification in the left anterior fossa of the skull.

Electroencephalography. Bifrontal slow wave foci, maximal on the right side.

Lumbar Puncture. Initial pressure of 140 mm. of water. Normal fluid, except for 160 mg. per 100 cc. of total protein.

Angiography (October 30, 1936). The right common carotid artery was injected percutaneously with thorotrast. Good visualization of both the internal and external carotid arteries was obtained on the right side. The right anterior cerebral artery was displaced posteriorly by a circumscribed mass on the floor of the anterior fossa (Fig. 12). The mass created upward displacement of the orbital and frontopolar branches of the anterior cerebral artery. Numerous newly formed vessels were visible within the mass and were sharply defined. The external carotid artery was seen to send small branches into the tumor.

Diagnosis. Meningioma of cribriform plate.

Course. The patient was ambulant the evening of the day angiography was done and no aggravation of symptoms or signs appeared.

Ventriculography (October 31, 1946). Bilateral elevation of the anterior horns of the lateral ventricles.

Craniotomy and extirpation (three stages) of bilateral meningioma of the cribriform plate by Dr. Eric Oldberg. Neoplasm examined microscopically and reported "Meningioma, meningotheliomatous type," by Dr. Percival Bailey.

Course. The patient gradually improved, following a period of apathy, listlessness, and euphoria, and was discharged on December 24, 1946, to the care of his family.

CASE VIII.

History. S. M. (No. 103721), a forty-two year

old white housewife, was admitted February 9, 1946 because of a convulsive seizure in September, 1945, an atatck of numbness on the right side with difficulty in speaking or remembering names in January, 1946, and an acute onset of headache, nausea, vomiting and weakness on the day of admission.

Examination. Acutely ill, without focal neurological signs.

Roentgenograms. Skull and chest, normal.

Lumbar Puncture. Initial pressure was 160 mm. of water. Normal fluid except for 106 mg. per 100 cc. total protein.

Clinical Impression. Cerebral thrombosis, parietal branches of left middle cerebral artery. To rule out: neoplasm in same region.

Angiography (February 12, 1946). The left common carotid artery was injected percutaneously with thorotrast. Angiograms showed a radiopaque area, 5 cm. in diameter, in the left precentral area near the vertex (Fig. 13). No abnormal vessels were present, either leading to or away from this well circumscribed mass. No vascular structure could be discerned within this radiopaque area. The major afferent vessel was the anterior cerebral artery (posterior portion of the pericallosal artery). The external carotid artery was poorly visualized on the examination. The posterior parietal branch of the middle cerebral artery was displaced downward in its distal course.

Diagnosis. Meningioma, left rolandic area.

Craniotomy and extirpation (two stages) of a vascular neoplasm by Dr. Paul C. Bucy. The neoplasm was examined microscopically and reported to be "Meningioma, psammomatous type."

Course. The patient made a gradual recovery and when discharged on April 7, 1946, she complained of minor tremor and weakness of the right hand and arm. Re-examinations in March, 1947, were normal, except for interval seizures.

Comment. It is of interest to note that a preoperative localization and diagnosis of meningioma was made angiographically in 5 of our 7 cases of meningioma. The sixth case was diagnosed "right frontal neoplasm, benign," and astrocytoma and meningioma were considered to be the most likely pathologic conditions. In the seventh case, angiography was done after exposure of the artery and injection of the internal carotid artery. The angiograms indicated a right frontal tumor. The type diagnoses considered were: (1) glioblastoma, and (2) meningioma. Craniotomy verified a meningeal tumor which received its major blood supply from the middle meningeal artery. We are of the opinion that the diagnosis of the meningioma could have been made angiographically if the common carotid artery had been injected, thereby visualizing the major blood supply of the tumor.

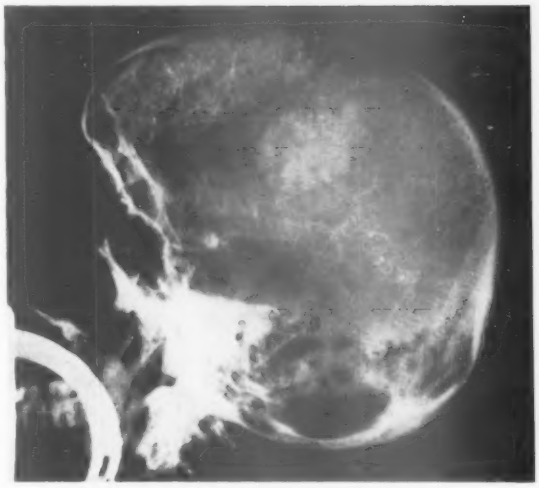

Fig. 13. Case VIII. Meningioma, precentral (verified).

Angiography is frequently not necessary to establish the diagnosis of meningioma. The clinical history and roentgenograms of the skull are adequate to make the diagnosis in many instances. In such cases, angiography is of aid to the neurosurgeon in determining the blood supply of the tumor, including the relationship of the external carotid artery. In patients, in whom the diagnosis is obscure (as in our Case VIII) angiography is invaluable and meningiomas can be recognized with a high degree of accuracy.

2. *Gliomas.* The two important neoplasms of this group are: (1) glioblastoma multiforme (28 cases), and (2) astrocytoma (4 cases). The other types of gliomas have less practical significance from the angiographic viewpoint. The object of such studies is to enable the surgeon to make an

FIG. 14. Case IX. Astrocytoma, left posterior frontal (verified).

anatomic and pathologic diagnosis preoperatively.

The *astrocytoma* is a relatively benign neoplasm. Its clinical course is sixty-seven months or more (Bailey[3]). Egas Moniz[12,14] states that such tumors have a definite angiographic appearance. As pointed out by Engeset,[21] Egas Moniz includes examples which contain abnormal vascular areas, characteristic of glioblastoma. Engeset emphasizes the necessity of classifying all gliomas which show the slightest pathological vascular changes within the tumor, as glioblastoma or malignant tumor. Our observations have led us to agree completely with this concept.

Angiographic characteristics of astrocytomata (modified from Engeset[21]):

1. Marked displacement of normal vessels.

2. Virtually no vessels within the neoplasm.

3. If vessels are seen within the tumor, they are small, thin, stretched, with sharp delimitations, even contours, normal caliber, and regular saturation.

4. If a cyst forms it is usually single and may attain considerable size. The displaced vessels exhibit a circular, arch-formed dislocation with long arcs, indicating a rounded process.

5. Such angiograms are also seen in oligodendrogliomas, ependymomas, abscesses and cholesteatomas. Oligodendrogliomas can often be ruled out by characteristic calcification. Abscess is ruled out by the clinical course. The other types are relatively insignificant. This group also includes transitional glioblastomas and cancer metastases in which the roentgen exposure is made too early.

These lesions are usually well suited for operative interference. There are 4 patients in our series in whom the diagnosis of "astrocytoma" was verified by surgical biopsy. All of these cases exhibited angiographic characteristics of "astrocytoma," with a definite localization being possible. Of 8 cerebral neoplasms, which were not verified, 4 satisfied the angiographic criteria for the diagnosis of "astrocytoma."

CASE IX.

History. S. Z. (No. 108111), a white female, aged twenty-three, was admitted on September 3, 1946, because of focal motor seizures of the right hand and arm of three months' duration.

Examination. Mild right hemiparesis and motor aphasia.

Roentgenograms. Skull and chest, normal.

Electroencephalography. Slow wave focus in the left frontal region, with normal background activity.

Angiography (September 5, 1946). The left common carotid artery was injected percutaneously. Angiograms revealed visualization of the internal carotid and external carotid artery on the left side. The internal carotid artery was normal to its bifurcation, but a rounded area of avascularity appeared in the rolandic area, causing downward displacement of the "group Sylvienne" (Fig. 14). The anterior cerebral artery appeared to be normal. No abnormal vessels were seen.

Diagnosis. Astrocytoma, left frontoparietal. The patient experienced slight tenderness at the site of the injection, but otherwise had no discomfort from the procedure.

Ventriculogram. Confirmed the localization, and craniotomy was done by Dr. Eric Oldberg. The neoplasm was identified in the cortex of the

left rolandic area and was biopsied. The tissues were reported to be "astrocytoma" by Dr. Percival Bailey.

Course. Considerable improvement, following craniotomy and deep roentgen therapy.

Comment. The localization and type diagnosis of astrocytomas of the cerebrum are readily obtainable preoperatively by means of angiography. We have had no experience with visualization of such neoplasms in the cerebellum and do not consider the procedure practical in this group of patients. In no instance were the symptoms or signs of neurological involvement aggravated by angiography. Although all of our cases of verified astrocytoma presented typical angiographic features, certain problems regarding differential diagnosis were encountered. On the basis of angiography alone, one is unable to differentiate an astrocytoma from a (1) brain abscess, (2) oligodendroglioma, (3) early glioblastoma multiforme, or (4) solitary cancer metastasis, in which the angiographic exposure was made too early to show the small vessels. We have localized several obscure lesions of the cerebrum angiographically and have considered the diagnosis of "astrocytoma" most likely, only to find the surgical pathology to be brain abscess (1 case), solitary cancer metastasis (1 case), and, undifferentiated glioblastoma multiforme (4 cases). On the other hand, the diagnosis of "astrocytoma" has been made angiographically in 4 of 8 patients, in whom the diagnosis of "glioma, unverified" was made on the basis of the clinical course and no biopsy was made. Subsequent case reports and discussion will illustrate the angiographic features of the more malignant neoplasms of the brain.

The *glioblastoma multiforme* is a malignant neoplasm which invariably causes death within about twelve months after its onset (Bailey[3]). Tönnis[58] noted that the veins of these tumors, when exposed at operation, contained arterial blood. Arteriograms have subsequently shown such arteriovenous connections within these tumors. These miliary aneurysms (Bailey[3]) are considered to be one of the main characteristics of glioblastomas. Hemmingson,[31] in 1939, made the diagnosis of glioblastoma multiforme by means of angiograms in 86 per cent of his 36 cases. He has pointed out a hypervascularization of the adjacent normal vessels in the tumor area. Hemmingson describes the glioblastoma as follows: "The malignant gliomata are, according to our experience, characterized by an abundant vascular supply in the tumor area. The vessels are irregularly arranged and of varying caliber. Between the vessels there are small, irregular spots which may be miliary aneurysms (Bailey). In addition there are sometimes arteriovenous fistulas with one or several veins, which lead from the tumor and are visible on the arteriogram. These arteriograms confirm both the clinical and pathological findings. We have never seen this type of picture in connection with other tumors than glioblastoma multiforme, nor have others, according to the literature. Our opinion is that these indications are pathognomonic for this form of tumor."

Lorenz,[45] in 1940, made the angiographic diagnosis of glioblastoma multiforme in 53 per cent of his 45 cases of glioblastoma. He emphasized the importance of exposing the film while the contrast substance is in the arteries and capillaries of the tumor area. Because of the variability of circulation tion, both arteriograms and phlebograms are essential, with as many transitional exposures as are technically possible. Lorenz classifies his cases into three groups, according to the degree of angiographic alterations. These are regarded as stages of dedifferentiation of the tumor.

Group I. 1. Poor visualization of normal vessels adjacent to the tumor area.

2. Very weak accumulation of contrast material in the tumor, i.e., indistinctness and spottiness.

3. Pin head-sized vessels, barely visible, which cannot be followed throughout their course, within the tumor area.

Group II. 1. Numerous new vessel formations: extremely thin and form an ir-

FIG. 15. Case x. Glioblastoma multiforme, orbitofrontal, of low malignancy (verified).

regular network. The crossing of these vessels is responsible for the abundant tiny spots in the tumor area. Corkscrew forms are frequent.

2. Spots of linseed size (lacunae) in the tumor.

3. Inability to follow the course of the newly formed vessels.

Group III. 1. More pronounced vascular changes: spiral course, larger caliber, thin vessels in the vicinity of the tumor, and less distant margins.

2. Looped veins in the tumor area, veins not being seen elsewhere. May resemble arteriovenous aneurysms, and disappear on the last phase of the phlebogram.

Engeset's excellent monograph[21] on angiography, in 1944, records 18 cases of glioblastoma multiforme, 77.7 per cent of which were diagnosed preoperatively by means of angiograms. He considers the irregular and variable saturations of the vessels of the tumor area to be characteristic of glioblastoma multiforme.

Our series included 28 patients in whom whom glioblastoma multiforme was verified surgically or at necropsy. Angiography provided accurate localizing and type diagnoses of glioblastoma multiforme in 22 cases, i.e., 78.5 per cent accuracy. The 6 patients in whom the diagnosis was not made were classified in the following manner: 4 cases, astrocytoma; 2 cases, not diagnostic. There were 2 patients in whom glioblastoma was considered on the basis of angiography, but further examinations disclosed a meningioma in one and a solitary metastasis to the temporal lobe in the other.

The following cases illustrate some of the applications of angiography to the problems created by the glioblastoma multiforme.

CASE X.

History. R. Z. (No. 108757), a housewife, aged fifty-four, was admitted on December 10, 1947, because of headache and amblyopia. Headaches had been bothersome for four years and partial blindness was present during the seven months prior to admission. She had suffered numerous generalized convulsive seizures for six months, and memory loss and urinary incontinence became apparent two weeks before hospitalization.

Examination. Amaurosis; secondary optic atrophy; anosmia and a very mild right hemiparesis.

Roentgenograms. Skull and chest, normal.

Laboratory Examinations. Normal.

Lumbar Puncture. Initial pressure was 180 mm. of water. Fluid, normal, except for 136 mg. per 100 cc. of total protein.

Electroencephalography. Bifrontal slow wave focus, especially on the right side, with abnormally slow background activity.

Clinical Impression. Intracranial neoplasm, probably meningioma of cribiform area, possibly bilateral.

Angiography (December 16, 1946). The right common carotid artery was injected percutaneously. Angiograms revealed normal external and internal carotid arteries, except for a marked posterior displacement of both anterior cerebral arteries, with areas of relative avascularity in the frontal poles (Fig. 15). The orbital branches appeared normal and the frontopolar branches were elvated. No new blood vessel formation, miliary aneurysms or arteriovenous shunts could be visualized.

Diagnosis. Astrocytoma, bifrontal. The patient experienced no unusual discomfort from the procedure.

Ventriculography. Confirmed the localization, showing obliteration of both anterior horns.

Craniotomy (December 18, 1946) by Dr. Eric Oldberg. A large tumor, "resembling an astrocytoma," was seen to extend from the right frontal lobe, across the corpus callosum, to the left frontal lobe. Most of the right frontal lobe was removed. The tissues were examined by Dr. Percival Bailey, who reported: "Glioblastoma multiforme, of low malignancy, probably starting as an astrocytoma."

Course. The patient was apathetic postoperatively but improved gradually and was discharged from the hospital on January 7, 1947.

Case xi.

History. C. A. (No. 90811), a housewife, aged fifty, was admitted on March 30, 1945, because of headaches, attacks of syncope, weakness of the legs, and occasional vomiting of two months' duration. Stupor began four days prior to admission.

Examination. Stupor; chronic papilledema (3 d.) bilaterally; partial oculomotor palsy on the right; left spastic hemiparesis, and a left homonymous hemianopsia.

Roentgenograms. Skull and chest, normal.

Laboratory Examinations. Normal.

Craniotomy by Dr. Eric Oldberg. An infiltrating neoplasm was seen in the exposed surface of the right temporal lobe. A cyst was encountered and 30 cc. of xanthochromic fluid was aspirated. Portions of the neoplasm were extirpated. The tissues were examined by Dr. Percival Bailey, who reported: "glioblastoma multiforme."

Course. The patient improved slowly.

Angiography (April 10, 1945). The right common carotid artery was injected percutaneously in the usual manner. The internal and external carotid arteries appeared to be normal. The internal carotid exhibited a double "carotid siphon." The anterior cerebral artery was normal. The middle cerebral artery was markedly elevated in its entire course (Fig. 16). There was a weak accumulation, with irregular saturation of contrast medium, within numerous small blood vessels, in the temporal region, inferior to the elevated middle cerebral artery.

Diagnosis. Glioblastoma multiforme.

Course. The procedure did not alter the improvement of the patient. She received roentgen therapy, 6,000 r, and was transferred to a convalescent hospital.

Fig. 16. Case xi. Glioblastoma multiforme, temporal (verified).

Case xii.

History. J. F. (No. 98280), a male, aged sixty-one, was admitted on February 22, 1945, because of headache and mental confusion for two weeks, urinary incontinence for four days, and a gradual loss of consciousness during three days prior to admission.

Examination. Deep coma; papilledema; intermittent Cheyne-Stokes respirations; left hemiparesis, and bilateral Babinski signs.

Laboratory Examinations. Normal, except for elevation of non-protein nitrogen (43 mg. per 100 cc.).

Roentgenograms. Skull and chest, normal.

Subtemporal Decompression, right. (February 24, 1945). The patient improved. In order to make a more accurate diagnosis, further studies were carried out.

Ventriculography (February 29, 1945). Expanding lesion in the right frontal region.

Roentgen Therapy. Dose of 7,500 r. Transient improvement and decline.

Angiography (March 8, 1945). The right common carotid artery was injected percutaneously in the usual manner. The external and internal carotid arteries were well visualized. The external artery appeared normal. The right frontopolar region was relatively avascular (Fig. 17) and there was an occlusion of the anterior cerebral artery near its origin. The

FIG. 17. Case XII. Glioblastoma multiforme, frontal (verified). Note miliary aneurysms and arteriovenous fistula.

middle cerebral artery appeared normal. Pronounced vascular changes were visible in the mid-frontal region, and included: (1) numerous miliary aneurysms and arteriovenous fistulas, (2) abnormal veins from this area leading to the superior longitudinal sinus, and (3) irregular saturation of abnormal vessels in this area.

Diagnosis. Glioblastoma multiforme, right frontal lobe. The patient's symptoms and signs were not altered by the procedure.

Electroencephalography (March 29, 1945). Slow wave focus, maximal in right temporal region.

Course. The patient gradually developed increasing intracranial pressure and died on June 13, 1945.

Necropsy. Large infiltrating neoplasm of the right frontal lobe, extending to the corpus callosum. "Typical glioblastoma multiforme."

CASE XIII.

History. A. A. (No. 109726), a white male, aged fifty-six, was admitted February 3, 1947, because of headache, mental confusion and singultus, which had been present for three days. He had been well until December 24, 1946, when it was noticed that the right corner of his mouth was paralyzed. A slight motor aphasia developed during the following week and gradually increased in severity.

Examination. Marked ideomotor aphasia; bilateral papilledema; right central facial paresis; absent right abdominal reflex, and singultus.

Roentgenograms. Skull and chest, normal.

Laboratory. Blood and urine, normal.

Angiography (February 4, 1947). The left common carotid artery was injected percutaneously with thorotrast. Angiograms showed the internal and external carotid arteries. The external carotid artery appeared to be normal. The internal carotid artery was normal to its bifurcation. The left anterior cerebral artery was normal. Elevation of the middle cerebral artery was apparent (Fig. 18*A*). An ovoid mass (3 by 4 cm. in diameter), partially circumscribed, was present in the left temporal region, with the temporal branches of the middle cerebral artery looped ever this mass. A few small miliary aneurysms were seen in the arteriogram. The phlebogram (Fig. 18*B*) exhibited many abnormal vessels within and around the mass, with elevation of the anastomotic vein of Labbé, and of the middle cerebral vein.

Diagnosis. Glioblastoma multiforme, left temporal lobe. The patient tolerated the procedure well and seemed stimulated by it. The time necessary to anesthetize the patient and to complete the angiography was twenty-five minutes.

Craniotomy (February 5, 1947). A left subtemporal exploratory decompression was done by Dr. Paul C. Bucy. A tumor was visualized in the superior temporal gyrus and measured 4 cm. in diameter at the surface, where it seemed to be partially circumscribed. It soon became apparent that the underlying white matter was infiltrated with neoplastic tissue. Most of the tumor was removed. The tissue was examined by Dr. Percival Bailey, who reported, "glioblastoma multiforme."

Course. The patient improved remarkably. He was alert, ambulant and slightly aphasic on discharge, February 12, 1947.

Comment. A review of the literature and clinical experience with angiography in 28 patients with glioblastoma multiforme are convincing evidence to us regarding the diagnostic accuracy and safety of the procedure in the management of these patients. Unfortunately, few clinical examinations of any type are 100 per cent accurate in every case, but this realization does not negate their use. Accordingly, any method which can provide a preoperative diagnosis of malignancy of the brain in 4

out of 5 cases should be considered to be practical.

Lorenz[45] has emphasized the correlation between the angiographic features and the degree of dedifferentiation of the glioblastoma multiforme. Our Case x exhibited the clinical, angiographic, and surgical characteristics of a benign glioma (astrocytoma). The microscopic appearance was

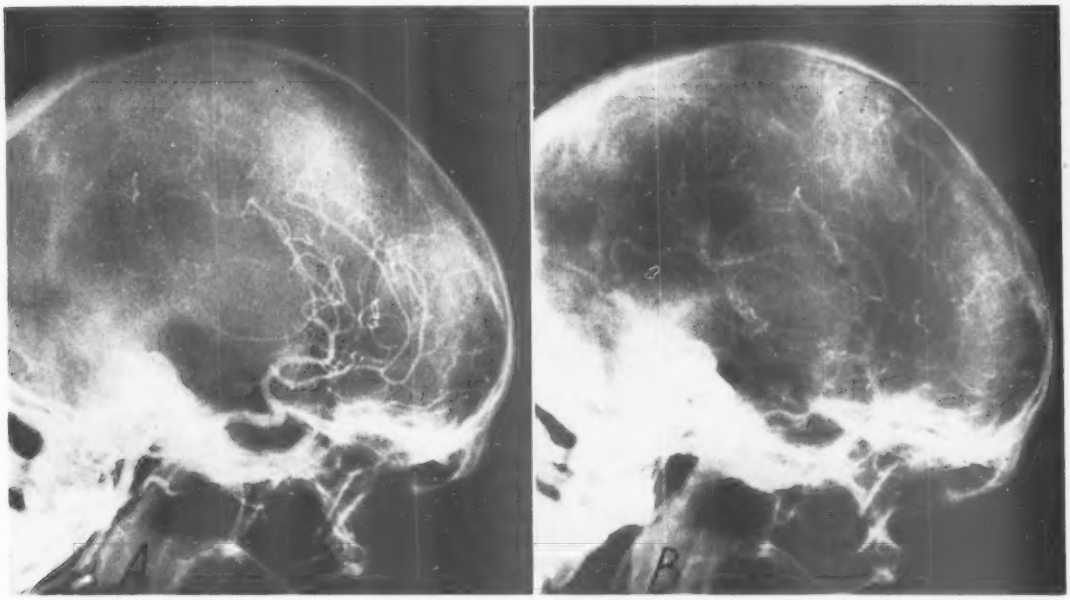

Fig. 18. Case xiii. Glioblastoma multiforme, temporal (verified). *A*, arteriogram. *B*, phlebogram.

that of glioblastoma multiforme of low malignancy with minimal vascular changes. Case xi presented clinical, angiographic, and histopathologic features of a glioblastoma multiforme, of low malignancy, with moderate vascular changes within the tumor. Case xii represents a group of patients in whom angiography is of considerable value. In these patients the clinical course suggests the diagnosis of glioblastoma multiforme, but the tumor is not definitely verified, even postoperatively. It is of considerable importance to the patient, relatives, and neurosurgeon to make a type diagnosis in order to accurately predict the future course of the illness. In addition, the roentgen therapist dislikes the treatment of unverified cerebral neoplasms. Angiography meets these requirements, where other methods have failed. Case xiii illustrates the facility with which localization and type diagnosis of the glioblastoma multiforme can be made preoperatively. This tumor was verified histopathologically and the patient improved considerably following the procedure. It is this postoperative improvement, which occurs in some cases of glioblastoma multiforme, transient as it may be, that inhibits us from withholding surgical intervention entirely.

3. *Cancer Metastases.* There are many patients who have a primary malignant tumor of an extracerebral organ and later show symptoms and signs of diffuse involvement of the cerebrum. The diagnosis of cancer with cerebral metastases offers no problem in these cases and the treatment is palliative. On the other hand, if the diagnosis of cerebral metastases is suspected and a primary lesion cannot be found, the nature of the pathology is frequently not verified until postmortem. Some patients with cerebral metastases present only the symptoms and signs of primary neoplasm of the brain. It is of considerable impor-

FIG. 19. Case XIV. Metastatic carcinoma, temporoparietal (verified).

tance to differentiate primary and secondary neoplastic disease of the brain as soon as possible. Angiography has proved itself to be a very useful diagnostic procedure in this regard.

Our series included 7 patients with cancer metastases, which were recognizable by angiography in 5 cases. The angiographic appearance of a metastatic lesion of the brain cannot be differentiated from glioblastoma multiforme with any certainty, unless there are multiple metastases. Metastatic lesions have a tendency to be more circumscribed than those produced by the malignant gliomas. Miliary aneurysms and arteriovenous fistulas are said to occur only in glioblastoma multiforme (Tönnis[58]). We are unable to differentiate the types of metastases on the basis of our present material. The primary lesions were found in the lung (3 cases), kidney (1 case), adrenal gland (2 cases) and prostate gland (1 case).

CASE XIV.

History. J. S. (No. 104576), a white male, aged fifty, was admitted June 14, 1945, for roentgen therapy of an unverified "glioblastoma" of the right temporal lobe. He had developed headache, amblyopia, left facial weakness, and bilateral papilledema during May, 1945. Ventriculography in another hospital disclosed collapse of the right lateral ventricle with dilatation and displacement of the left lateral ventricle, indicating a huge tumor of the right hemisphere. A right subtemporal exploratory decompression was done the same date (May 22, 1945). Needle palpation revealed an extremely soft infiltrative lesion, probably a "glioblastoma." He improved slightly and was transferred for further treatment.

Examination. Bulging, tense, right subtemporal decompression; secondary optic atrophy, and left hemiparesis.

Electroencephalography. Large slow wave focus in the right hemisphere, maximal in the right temporoparietal area.

Roentgen Therapy. Seventy day period. Tentative diagnosis, "glioblastoma multiforme," right temporal lobe.

Angiography (August 7, 1946). In an attempt to obtain a type diagnosis to guide further treatments, the right common carotid artery was injected percutaneously with thorotrast and angiograms were made. The external carotid artery did not visualize. The internal carotid artery appeared normal, except for the posterior temporoparietal area (described below). The ophthalmic artery, both anterior cerebral arteries, and the ascending frontoparietal branches of the right middle cerebral artery were visualized and apparently normal. The anterior temporal branch of the middle cerebral artery was not displaced. The distal portion of the middle cererral artery was elevated by a circumscribed mass (3 cm. in diameter) in the temporoparietal region (Fig. 19). Several tortuous arteries (posterior temporal) and veins were seen to supply this area with blood. The veins drained into the straight sinus. The lateral sinus was also visualized on the arteriogram. No other abnormal arteries or veins were seen, other than those in and around the mass. The mass itself was annular. A dense rate of minute vessels appeared in its periphery, and was in direct communication with a centrum of fine radiating capillaries, traversing an anteroposterior course for the most part. Small capillaries with even saturation encircled the mass.

Impression. Malignant neoplasm, right temporoparietal region, most likely a cancer metastasis. To rule out glioblastoma.

Course. The patient was discharged upon completion of the roentgen therapy, August 8,

1945, and was subsequently treated as an out-patient. He died on March 15, 1946.

Necropsy. Metastatic tumor in the right temporal region, and a primary carcinoma of the left adrenal gland.

Case xv.

History. H. J. (No. 108017), a policeman aged fifty-three, was admitted October 29, 1946, because of gradual weakness and focal motor seizures of the left foot and leg since August, 1946.

Examination. Moderate left hemiplegia, most marked in the lower extremity, evidence of recent weight loss (10 lb.), and a questionable mass in the right flank area.

Roentgenograms. Skull and chest, normal.

Lumbar Puncture. Initial pressure, 200 mm. of water. Cerebrospinal fluid was normal, except for 104 mg. per 100 cc. total protein.

Clinical Impression. Parasagittal meningioma, right. To rule out carcinoma.

Electroencephalography. Focus of slow activity in right parieto-occipital area.

Angiography (November 2, 1946). The right common carotid artery was injected percutaneously with thorotrast. Angiograms revealed visualization of the right internal and external carotid arteries. The ophthalmic artery appeared normal. The right anterior cerebral artery was normal to its pericallosal portion. The intermediate medial frontal branch of this vessel was obliterated by a circumscribed annular mass, approximately 1.5 cm. in diameter (Fig. 20). The periphery of this mass was replaced by a narrow band of small vessels in a reticular configuration. Irregular filling occurred in the centrum of the mass. A larger mass (1.5 by 2 cm.) was seen at the termination of the posterior medial branch of the pericallosal artery, and showed a similar rete in its well circumscribed periphery. The largest mass was seen in the mid-parietal region, and measured 2.1 by 2.3 cm. and appeared at the termination of the pericallosal artery. This area was densely radiopaque, circumscribed and showing a fine rete of capillaries in its periphery. The middle cerebral artery appeared to be essentially normal, and to send anastomotic branches to the posterior masses.

Diagnosis. Cancer metastases, right parasagittal region near vertex, right.

Course. Craniotomy was, therefore, considered futile and a search for the primary cancer was re-emphasized. Intravenous pyelography

Fig. 20. Case xv. Cancer metastases, fronto-parietal (verified).

was inconclusive, but suggested a mass in the right kidney. Retrograde pyelography revealed a neoplasm of the right kidney and the diagnosis of *hypernephroma* with *cerebral metastases* was made. Deep roentgen therapy was given to the head and kidney. Physiotherapy to the paretic extremity was also administered. The patient responded remarkably well, gained weight and became ambulant. He was discharged on December 28, 1946, and continued to receive roentgen therapy as an out-patient. Re-examination on February 6, 1947 disclosed no neurologic findings, except for a left Babinski sign. He did well, even doing odd jobs for another month and then died.

Necropsy. Hypernephroma of right kidney, with cerebral metastases.

Comment. Cancer metastases are frequently recognizable only by angiography, ante-mortem. Case xiv indicates its application in a patient in whom a neoplasm was not verified at surgery. Case xv illustrates the value of angiography preoperatively. The symptoms and signs in this patient were suggestive of a parasagittal meningioma. Minor findings indicated the possibility that the cerebral pathology might be metastatic. Angiography confirmed this, thereby preventing a needless craniotomy. The diagnosis of a primary hypernephroma was made soon thereafter and was verified at necropsy.

Angiographic Characteristics of Cancer Metastases:

1. When solitary, they may be confused with glioblastoma multiforme.
2. When multiple, the findings are pathognomonic.
3. Masses tend to be annular, circumscribed and radiopaque.
4. A capillary rete is frequently seen in the periphery of the mass.
5. The centrum of the mass may be indistinct, completely radiopaque, or show well saturated fine radiating capillaries.
6. Masses tend to form near the termination of major vessels and, accordingly, usually show less displacement of vessels than other tumors.
7. Definite military aneurysms are not seen as in glioblastoma multiforme.

Table II

THE ACCURACY OF ANGIOGRAPHY IN THE LOCALIZATION AND TYPE DIAGNOSIS OF NEOPLASMS IN 58 PATIENTS

Tumors	Number of Patients	Diagnosis by Angiography
Meningiomas	7 (verified)	5
Sarcoma of meninges	2 (verified)	0
Gliomas		
Astrocytoma	4 (verified)	4
Glioblastoma multiforme	28 (verified)	22
Miscellaneous		
Subependymal plate	1 (verified)	0
Third ventricle	1 (verified)	0
Cancer metastases	7 (verified)	5
Unverified tumors	8	5
	58	41

III. MISCELLANEOUS CONDITIONS

Pathological findings, other than those described under vascular and neoplastic disease, were visualized by angiography in 5 of our cases. All of these patients presented interesting diagnostic problems. In one instance, a clinical diagnosis of neoplasm was made, but angiography revealed a chronic subdural hematoma, which was drained surgically. One case was diagnosed clinically "glioblastoma multiforme." Angiography was performed and was interpreted as "astrocytoma." Craniotomy disclosed a poorly localized abscess of the brain. The angiographic picture of astrocytoma and brain abscess are frequently identical as in this angiogram.

Another patient had suffered a severe craniocerebral injury ten years prior to admission. Ten days after the accident he gradually became confused and developed a right hemiplegia. He improved slowly and recovered, until the following year when convulsive seizures began. The seizures were focal, commencing in the right upper extremity. Angiography revealed occlusion of the left middle cerebral artery, presumably of traumatic origin. The accuracy of the diagnosis was of considerable help in determining the future management.

Brain Abscess. Reichert[50] prefers angiography to ventriculography in cases of abscess, because of the localization afforded and the avoidance of needling of the brain. Our abscess patient developed a complete motor aphasia following angiography and his general condition seemed to deteriorate more rapidly than it had prior to the procedure. The abscess was subsequently drained. It is difficult to evaluate whether the aphasia was produced by a spontaneous extension of the abscess or whether it resulted from local thrombosis secondary to angiography. Improvement following surgical drainage and chemotherapy suggests that the aggravation of symptoms may have been due entirely to the natural progress of the abscess itself.

Cerebral Trauma. Löhr[40] advocates angiography in all cases of acute head injuries, in which the condition is grave and when a diagnosis cannot be established in any other way. We have not applied the procedure to such cases and do not intend to until more evidence accumulates to indicate its value. Angiography offers a pathognomonic picture in *chronic subdural hematoma.* This is of great value in differentiating subdural

hematoma from cerebral neoplasm or abscess. Cerebral pneumography is to be preferred when chronic subdural hematoma is the prime consideration and diagnostic trephinations have failed to reveal pathology.

Basal skull fractures are occasionally complicated by an *arteriovenous fistula of the internal carotid artery within the cavernous sinus*. Such an arteriovenous aneurysm may occur spontaneously in 25 per cent of cases (Dandy[8]). It causes a pulsating exophthalmos on the side affected and is ordinarily recognized clinically. Angiography visualizes the new circulatory mechanism and is of great value in planning surgical treatment. If the carotid artery on the affected side is injected, the radiopaque substance is seen to be shunted into the cavernous sinus and eventually to the jugular vein, via one of several venous pathways.

Accordingly, the cerebral hemisphere on that side receives little or no arterial blood from the ipsilateral carotid artery. This hemisphere receives most of its blood from the contralateral carotid artery and from the vertebral artery. Löhr[41] recommends bilateral carotid angiography in such cases, because (1) injection of the affected side reveals the size and localization of the arteriovenous aneurysm, and indicates the main venous return, and (2) injection of the normal side visualizes the efficiency of collateral circulation. If the collaterals are sufficiently developed carotid ligation in the neck in the affected side can be done with safety (Dandy[8]).

INDICATIONS AND CONTRAINDICATIONS FOR ANGIOGRAPHY

I. *Diseases of Blood Vessels*. Cerebral angiography should not be used in every suspected vascular lesion of the brain. Although the method is accurate, it is not uncomplicated in technique and requires the perfusion of a radiopaque substance through a diseased vascular system. It is necessary to inject such a substance under pressure and the recognition of the possibility of increasing the damage of the vessel (rupture, thrombosis or spasm) must be realized. We have had no instances in which such complications occurred following angiography, and agree that "no such ill effects need to be feared if proper technique and indications are used" (List and Hodges[39]). It has been our practice to delay angiography for at least six weeks after an aneurysm has "leaked" into the subarachnoid space and two weeks following a suspected occlusion of a major blood vessel of the cerebrum.

Angiography is contraindicated in most instances of acute cerebrovascular hemorrhages, thromboses or emboli, and is hazardous in old patients with cardiac decompensation, hypertension and advanced atherosclerosis.

We recommend cerebral angiography in preference to air studies for the localization of aneurysms, traumatic arteriovenous aneurysms, vascular malformations of the brain and in those numerous cases where the diagnosis is difficult between primary vascular disease and glioblastoma multiforme in which vascular disturbances have occurred (Globus and Strauss,[25] Riley and Elsberg[51]) including "acute brain tumor" (Elsberg and Globus[19]).

II. *Cerebral Neoplasms*. In many patients with brain tumor, the localization of the neoplasm is apparent following clinical examinations. Roentgenograms of the skull (by erosion and decalcification) and chest (carcinoma) suggest the pathological nature of some of these tumors.

Accordingly, direct treatment is indicated and further studies, such as ventriculography or angiography, are unnecessary.

If the localization is indefinite, it is common practice to utilize ventriculography or pneumoencephalography. These methods are well established as practical measures of importance in the diagnosis of brain tumor but rarely suggest the pathologic nature of the neoplasm. Cerebral angiography is also valuable, especially for this latter purpose and should supplement the other methods. Both air and vascular studies were made in many of our cases for comparative pur-

poses. If a cerebral neoplasm is suspected and lateralizing findings are absent, ventriculography or pneumoencephalography is indicated. Tumors of the ventricular system and posterior fossa require ventriculography; angiography is not recommended in this group.

Cerebral angiography is indicated primarily in supratentorial neoplasms in which lateralizing findings are present. Patients with increased intracranial pressure tolerate angiography remarkably well. Tönnis[59] emphasized angiography in a particular group of patients in whom the history of increasing intracranial pressure is long and the etiology is obscure (glioblastoma multiforme, brain abscess, or chronic subdural hematoma). A definite differential diagnosis between parasellar tumor and aneurysm can be made preoperatively only by angiography (List and Hodges,[39] Hermann, Obrador and Dott[32]). We are impressed by a group of patients in whom primary brain tumor was suspected, and cancer metastases were found angiographically. Accordingly, angiography is recommended, in preference to air studies, for the localization and especially the type diagnosis of hemispheral neoplasms, whether primary or secondary, with the exception already mentioned.

III. *Miscellaneous.* At the present time, the diagnosis of brain abscess and chronic subdural hematoma can usually be made by methods other than angiography. These conditions produce definite angiographic changes and the method is recommended when other diagnostic measures fail.

SUMMARY AND CONCLUSIONS

1. A brief summary of the history of cerebral angiography is recorded. Attention is called to the fact that the procedure is rarely applied to the diagnosis of cerebral neoplasms in America.

2. The anatomy and physiology of cerebral circulation in relation to angiography are discussed.

3. The techniques of cerebral angiography are described. The percutaneous method is recommended. Angiography following the surgical exposure of the artery is necessary only in those few cases in which the artery cannot be cannulated percutaneously. Radiopaque materials are discussed; diodrast is preferred for routine use.

4. Clinical experience with cerebral angiography in 107 cases is illustrated. The material includes 58 neoplasms. The localization and type diagnosis of malignant tumors are made with high accuracy. The glioblastoma multiforme was recognized in 22 out of 28 verified tumors of that type. Cancer metastases were diagnosed on the basis of angiography in 5 out of 7 verified cases. Angiographic characteristics of the various tumor types are described. The clinical value of angiography in the diagnosis and treatment of aneurysms and vascular malformations is re-emphasized.

5. The procedure is considered to be safe if proper technique and indications are used. In over 107 patients there was no mortality due to angiography. Two patients experienced transitory aggravation of symptoms. Four patients showed mild allergic reactions to diodrast, in spite of sensitivity tests.

6. The indications and contraindications for cerebral angiography are discussed. Air studies are preferred for the localization of obscure lesions of the ventricular system, of the posterior fossa, and those above the tentorium in which lateralizing findings are absent. Air studies usually do not provide a diagnosis of the pathologic type of tumor and also necessitate craniotomy the same day if there is increased intracranial pressure. Angiography is well tolerated by patients with intracranial hypertension. It is considered to be the procedure of choice in the diagnosis of aneurysms, vascular malformations, parasellar lesions, and in supratentorial pathology (including tumors) if lateralizing findings are present. It is highly recommended in those numerous cases where the diagnosis of primary vascular disease cannot be made from that of cere-

bral neoplasm in which vascular disturbances have occurred.

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Vol. 59, No. 5

ROENTGEN CONSIDERATIONS OF PYELONEPHRITIS IN SMALL KIDNEYS*

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IN RECENT years, the significance of the demonstration of a unilateral small kidney has become greatly intensified. This has been due largely to the interest stimulated by the work and discoveries of Goldblatt[9] and succeeding investigators in regard to the relationship between arterial hypertension and renal pathology. The complete evaluation of the individual case in regard to that relation requires all of the diagnostic and interpretive aids possible in addition to those furnished by roentgenologic means, but the clinical demonstration of the existence of gross abnormalities of the kidney prior to operation or autopsy has been possible in large part only through roentgenographic means and their elaboration in intravenous and retrograde contrast methods. When a small kidney is shown in such circumstances, interest is immediately evoked, but it should be obvious that the finding is of importance to the clinician and urologist from many other aspects than its possible relationship to arterial hypertension.

In the performance and interpretation of urographic studies we have considered it valuable, if not essential, to cultivate a viewpoint which emphasizes manifestations of physiological and pathological abnormalities as well as gross morphological changes. The purpose of this paper is to relate such analytical observations to the problem of the unilateral small kidney, with special reference to the findings in atrophic chronic pyelonephritis.

Method of Study. In the roentgenographic consideration of the kidney from the dynamic as well as the anatomical aspect, the following scheme of analysis has proved to be useful:[25]

I. Gross Anatomy of the Kidneys.
   a. Position, size, shape and axis of the kidneys.
   b. Density of the kidney shadow.
   c. Delineation of the kidney from surrounding structures.
   d. Mobility of the kidney as a whole.
II. Roentgenologic Quality of Clearance of Contrast Media.
   a. Selection of contrast medium for testing of tubular or glomerular function or both.
   b. Comparison of clearance from both kidneys.
   c. Comparison of urea clearance with skiodan excretion.
   d. Determination of delay in excretion.
III. Anatomy of the Renal Pelvis and Calices.
   a. Number and configuration of the calices.
   b. Character of filling.
   c. Position of renal pelvis, intrarenal or extrarenal.
   d. Relative proportion of medulla and cortex.
IV. Physiology of the Renal Pelvis and Calices.
   a. Character of peristalsis.
   b. Elasticity of the pelvic structures and consideration of reversibility of any dysfunction.
   c. Disturbance in emptying.

Systematic employment of these criteria has made it possible to extract more information from the urographic studies than is obtained with a more casual procedure, as will be apparent in the case studies to follow.

Pathology of the Unilateral Small Kidney. A kidney of significant smallness in size may be present as a result of malformation in development or of atrophy from acquired disease, or both. Clinically, it is not

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possible to make this distinction in many cases. As a matter of fact, the criteria for distinguishing between them pathologically have not been sharply drawn, especially in those cases where there seem to be elements of both present. In the inception of our study it was hoped that we might be able to demonstrate consistent differential features between acquired atrophy and developmental hypoplasia by roentgenographic means. This quest has not been wholly successful and the distinction in certain cases appears to be too subtle for roentgenographic methods, although pertinent indications as to the nature of the abnormal kidney may be shown.

Hypoplasia of the Kidney. A reasonable definition of the hypoplastic kidney, as proposed by Johnson and Wayman,[17] is that of a kidney which is small as a result of defective development, but which contains functioning renal tissue. In this classification, the term agenesis is reserved for complete absence of renal tissue, a condition which is accompanied by absence of the ureter on the affected side in 90 per cent of cases. The term aplasia is used synonymously with agenesis or to include those cases in which the ureter ends, proximally, in a mass of tissue in which no glomeruli or tubules are demonstrable, i.e., no functioning units present. In the understanding of the mechanism of production of renal anomalies, attention is directed to the double embryological origin of the adult kidney from the ureteral bud of the wolffian duct and the metanephric anlage, as well as the complex mechanisms of migration, ascent, and rotation during development.[6,10] The incidence of hypoplasia in large series of autopsies has been variably quoted[6,10] at figures between 1:600 and 1:3,000. The precision of methods used in the pathological differentiation from acquired atrophy influences the credibility of these figures and a conclusive diagnosis may not be possible even with gross and microscopic pathological study.

The morphology of the hypoplastic kidney is described as varying from a rudimentary pelvis with a small cap of cortical tissue, sometimes asymmetrically placed, to a kidney of essentially normal structure and configuration except for its diminutive size.[10] Reduction in the number of calices and papillae below normal is reported to be good evidence of hypoplasia if well demonstrated,[6] as is also the persistence of fetal lobulation.[17] Defective arterial development has been described and thought to bear an etiological relationship in some cases.[10] Of possible correlative interest is the work of Bagg,[1] who found hypoplasia and agenesis of the kidneys in the progeny of experimentally irradiated mice.

Acquired Atrophy. Among the diseases which may be responsible for an acquired unilateral renal atrophy, the most important seem to be:

1. Atrophic chronic pyelonephritis.
2. Primary atrophy.
3. Pyonephrosis.

1. Atrophic Chronic Pyelonephritis. In the majority of recent studies, this condition has been cited as the most frequent pathological entity responsible for unilateral renal atrophy. The urological importance of chronic pyelonephritis has been repeatedly emphasized in this country in the contributions of Braasch and his coworkers.[3,4,5] These investigators have also reported an important relationship between hypertension and chronic atrophic pyelonephritis not found with other surgical renal lesions.[5] The statistics of Shure,[27] based on autopsy material, verify that finding. In regard to incidence, Hage[11] reports 69 contracted pyelonephritic kidneys in 9,888 autopsies. Of his group, 60 per cent were in females, with an even higher percentage in younger age periods. No predilection for the right or left side was noted.

The mode of pathogenesis of pyelonephritic infections is classically divided into ascending and hematogenous forms. It is usually difficult or impossible to specify which mechanism is applicable in the acute phase of an individual case; in the chronic phases one has even less hope of ascertain-

ing the mode of pathogenesis. The sequence of events operating in the production and maintenance of retrograde pyelonephritic infection has been the subject of experimental work as well as theoretical consideration. Montaldo[22] reports the experimental production of pyelonephritis eventuating in an atrophic kidney. It was his impression that low virulence of organisms and low grades of obstruction to urinary drainage were contributory elements in the production and maintenance of the pyelonephritic form of disease which produces contraction. The backflow mechanisms, particularly the pyelotubular and pyelovenous forms, have been brought into the picture in explanation of methods of spread of infection from the renal pelvis, presuming an increased intrapelvic pressure.

We do not know how important obstruction is in pyelonephritic infection[18] but it is of interest that no evidences of obstruction at the renal pelvic or ureteral level have been noted in our cases of atrophic kidneys and we have excluded those cases in which stones were present. In the urographic studies of active or early chronic pyelonephritis, however, infundibular narrowing is often noted and may be related to localized intrarenal elevation of pressure.[15]

In the pathological examination of the chronic pyelonephritic kidney with atrophy the distribution of the changes is reported to be variable, but the basic manifestations of the disease show certain characteristics. Cortical scarring has usually replaced glomerular and tubular structures more or less completely, with corresponding thinning of the cortex. Histologically, the tubules are described as showing atrophic epithelium and colloid material is seen in the involved tubules; sometimes the tubules show thyroid-like acinar structure in heavily scarred zones. The periphery of Bowman's capsule is thought to be attacked primarily, but sclerosis of the glomerular tufts may be found in scarred areas. Lymphocytic infiltration varies with the activity of the remaining infection. Attention has been centered on the changes in the arteries and the arterioles. Weiss and Parker[30,31] have postulated a vicious circle in which sclerotic changes are linked with hypertension. Little pathological change is reported in the wall of the calices and renal pelvis, other than moderate thickening and submucosal scarring which may, in instances, isolate islands of epithelial cells.[19] It is our impression that considerable change in these structures is manifested by urographic demonstration of fixation, loss of elasticity and peristalsis. The elaboration of urographic dye may remain remarkably good if a sufficient number of functioning units is left in the scarred parenchyma.

2. Primary Atrophy. This form of atrophy is considered to be rare in the kidney, though it is the usual mechanism of atrophy of other secretory organs when there is occlusion of their ducts. It may occur in the kidney on anuria from obstruction, but the unique mechanism of hydronephrosis is the usual reaction of the kidney to such obstruction. The hydronephrotic kidney may result in an atrophic small kidney, but this is usually in the presence of secondary infection, and is termed pyonephrosis.[14]

3. Pyonephrosis. This is defined as a secondarily infected hydronephrosis. Though the clinical origin is different, the small kidney which may be the end result of this condition is essentially indistinguishable pathologically and roentgenographically from atrophic chronic pyelonephritis.

Roentgenologic Considerations. The division of the origin of the small kindey into the above categories appears to be rational, with the exception of the difficulties mentioned in regard to precise pathological differentiation. An additional difficulty is presented, however, when the coexistence of a hypoplastic background with superimposed pyelonephritis is suggested. Moreover, from the roentgenologic standpoint, there are several interesting observations that are difficult to explain, i.e.:

a. There is a small kidney with or without urographic evidence of pyelonephritis

found on the first examination on every one of the patients whom we have studied. On only one occasion did we observe a slight diminution in the size of the kidney shadow after four years (Case IV).

b. The small kidney when found has been in both children and in adults. Histories of previous infection have not been informative (Case VII).

c. Many cases of pyelonephritis are observed in which the kidneys are not small. In bilateral pyelonephritis, only one kidney has appeared to be small in practically every instance.

d. We have found small kidneys, presumably hypoplastic, in which there was no clinical evidence of disease. Yet, if there was clinical evidence of disease, or if the patient were hypertensive, such a small kidney found on a urographic study might lead one to suspect either pyelonephritis with a contracted kidney, or renal relationship to the hypertension. Similar observations obtain in the contracted kidney of pyelonephritis and thus far we have been unable, with urography, to differentiate with certainty between hypoplasia and the small kidney with pyelonephritis.

Before considering illustrative cases in regard to these points, a review of the analytical findings in regard to the kidneys shown is presented.

Approximately 60 cases have been observed by us in which a unilateral small kidney has been found. The evidences of abnormality have shown considerable variability, but have usually been marked in more respects than size alone. Considering the gross anatomical aspects, in addition to diminution in size, one frequently finds unusually sharp demarcation of the renal contour from the surrounding soft tissue densities. No ready explanation for this appearance is forthcoming, but it is a remarkably constant observation. If changes in the cortex are not uniform, the axis of the kidney may become vertical.

Many cases appear to exhibit restriction of mobility of the kidney as a whole.

Such fixation may be the result of capsular inflammatory changes short of the development of significant perinephritic infection at any stage (Case II).

The clearance of intravenous contrast medium is often demonstrably impaired, as would be expected in advanced secondary loss of functioning units in the case of acquired disease, or with hypoplastic deficiency in the number of functioning units (Cases I, III and VIII).

The anatomical aspects of the renal pelvis and calices have been of especial interest. The number of calices may be worth determining, but an appearance of lessened number, though suggestive of hypoplasia may be due to lack of filling and demonstration in an atrophied organ. The character of filling must be evaluated, inasmuch as impaired clearance is often present; retrograde visualization should be considered when delineation of detail of the caliceal and pelvic anatomy is of special value (Cases III and V).

The relative proportion of medulla and cortex has been the subject of particular observation. In chronic pyelonephritis with atrophy, we frequently find marked thinning of the cortex, with close approximation of the calices to the peripheral renal outline. This might be a reliable differential feature of acquired atrophy, and we are inclined to view it with that interpretation, but the description of forms of hypoplasia in which an asymmetrical cap of cortical tissue surmounts the renal pelvis injects an element of doubt into the precision of the sign (Cases I and IV).

The physiology of the renal pelvis and calices is best studied with the excretory contrast method. Here we find evidences of irreversible pathological changes affecting the muscular peristalsis and elasticity of the collecting structures in a large proportion of atrophic pyelonephritic kidneys. These features are best demonstrated in serial studies in the supine, Trendelenburg, and semi-erect positions (Cases I and VIII); also by comparison with the opposite kidney. The contralateral kidney may, likewise, be involved in irreversible changes

without atrophy and with compensatory hypertrophy (Case IV). Disturbance in emptying may be found in the absence of mechanical obstruction and on the basis of fixation of the renal pelvis and calices (Case III).

REPORT OF CASES

CASE I. A white woman, aged twenty-one, with recurrent attacks of urinary tract infection, studied immediately after an acute attack

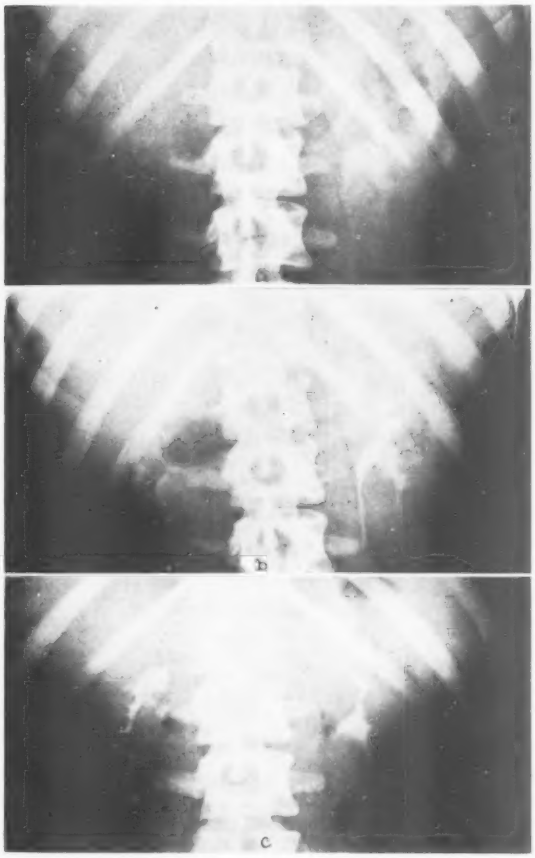

FIG. 1. Case I. Diagnosis: Chronic pyelonephritis with contracted right kidney; double pelvis and ureter anomaly on the right. Intravenous urograms: (*a*) five minutes, supine; (*b*) ten minutes, Trendelenburg: (*c*) twenty minutes, erect. The roentgenographic findings are typical of those that we have come to regard as roentgen evidence of atrophic pyelonephritis. The small right kidney shows delay in elaboration of contrast medium, some diminution in function, and disturbance in emptying with irreversible changes in the peristalsis and elasticity of the calices and pelvis. The cortex is markedly narrowed.

FIG. 2. Case I. Detail view of the right kidney in the same case as Figure 1. Intravenous urogram at the end of one hour.

with typical symptoms. There was right flank pain and tenderness. Culture of the urine showed *Staphylococcus albus* (hemolytic) and *Escherichia coli*. No hypertension was found. The urographic study shows a small right kidney with changes that we consider to be typical of chronic pyelonephritis. There is also an anomaly of the right kidney with double pelvis and ureter. No operation was performed.

Impression: Chronic pyelonephritis with contracted right kidney; double pelvis and ureteral anomaly on the right (Fig. 1 and 2).

CASE II. A white woman, aged forty-four, with a twelve year history of recurrent left urinary tract infection. An acute episode of fever, left flank pain, and pyuria was subsiding when the examination was made. There was no hypertension. No operation was performed.

Impression: Chronic pyelonephritis with contracted left kidney (Fig. 3).

CASE III. A white girl, aged fourteen, with a history of an acute febrile episode eighteen

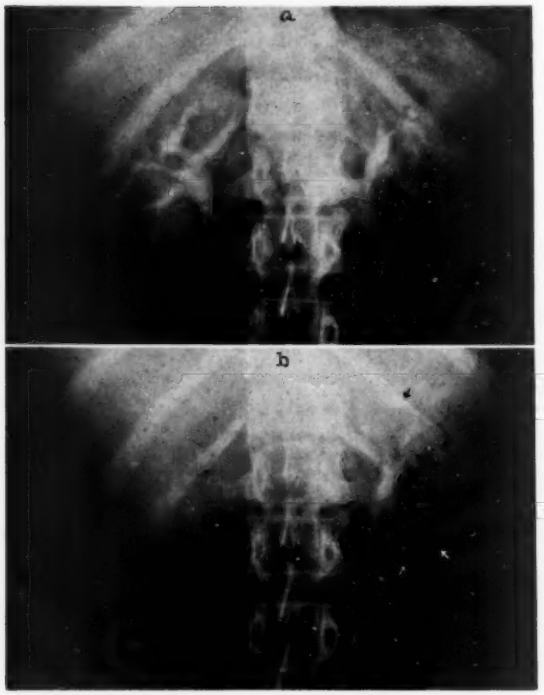

FIG. 3. Case II. Diagnosis: Chronic pyelonephritis with contracted left kidney. Intravenous urograms: (*a*) ten minutes, Trendelenburg; (*b*) twenty minutes, semi-erect. Although it is small, the left kidney shows good function. In the semi-erect position, there is poor emptying of the left kidney, which is frequently observed in contracted pyelonephritic kidneys. Another frequent observation is demonstrated in the sharp demarcation of the renal outline by what appears to be a zone of decreased density.

months previously which was diagnosed as an acute pyelitis. Six months before the examination she had a convulsive seizure and was found to be hypertensive; a left hemiparesis developed. Evidences of increased intracranial pressure continued during the six month period before examination. At the time of this examination there was hypertension (blood pressure 180/130), residual weakness of the left side of the body, with spastic tendency, and retinal arteriosclerosis. A ventriculogram showed a bilaterally enlarged ventricular system, more marked on the right, apparently due to cerebral atrophy. After the urographic examination, the small, non-functioning left kidney was surgically removed. The pathological examination was reported as showing chronic pyelonephritis with secondary atrophy, although the possibility of an underlying hypoplasia was considered by the pathologist.

Four years after nephrectomy, a follow-up reports the patient to be in excellent health with normal blood pressure. Only a slight weakness of the left side of the body remains.

Impression: Atrophic chronic pyelonephritis, left, in a patient with hypertension and cerebral atrophy (Fig. 4).

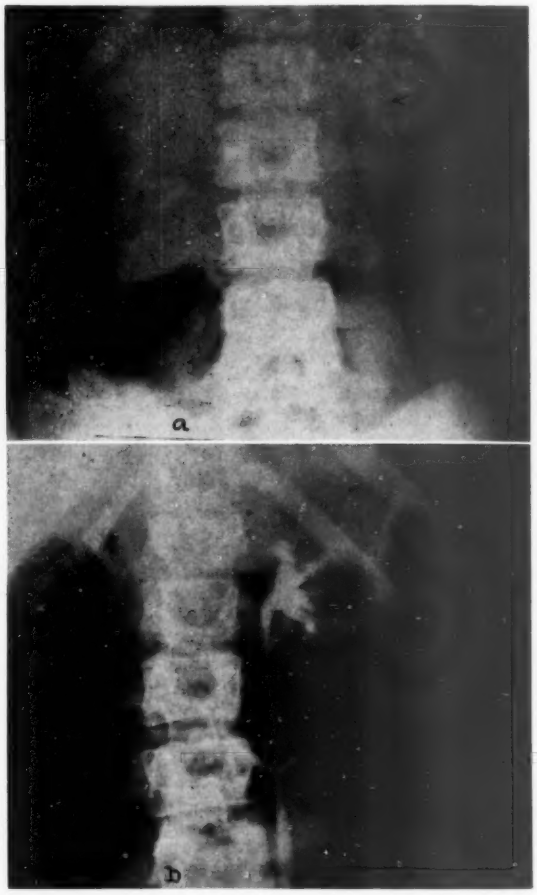

FIG. 4. Case III. Diagnosis: Atrophic chronic pyelonephritis, left, in a patient with hypertension and cerebral atrophy. (*a*) intravenous urogram, twenty minutes, semi-erect; (*b*) retrograde pyelogram, left. The upper illustration (*a*) shows a poor dye shadow in the right kidney and lack of contrast visualization of the collecting structures on the left, with a very small left kidney outline. In the retrograde examination (*b*), the cortex of the left kidney is seen to be markedly narrowed and there is distortion of the calices.

CASE IV. A white male, aged fourteen, with a four year history of urinary tract infection and hypertension (blood pressure 230/160). At the time of the first examination an obstruction at the prostatic utricle was removed. Numerous

ureteral catheterizations showed bilateral upper urinary tract infection; urine culture positive for *Staphylococcus aureus*. No operation was performed. The case is shown to demonstrate slight progression in diminution of size of the small right kidney during the four year interval between examinations.

Impression: Atrophic chronic pyelonephritis (Fig. 5).

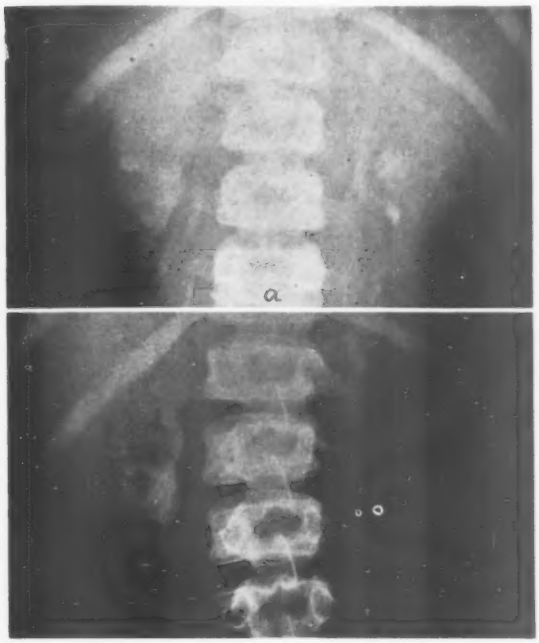

Fig. 5. Case IV. Impression: Atrophic chronic pyelonephritis. Intravenous urograms: (*a*) May 24, 1934; (*b*) April 2, 1938. There is evidence of bilateral pyelonephritis with a small right kidney. The first examination (*a*) was made four years before the second examination (*b*). There appears to be progression of diminution in size of the right kidney.

Case V. A white male, aged thirty-nine, with a four year history of intermittent pain in the right upper quadrant of the abdomen. The urinalysis showed pus, but no culture was reported. There was no hypertension. No operation was performed.

In the urographic examination the right kidney is small but, although there is clinical evidence of urinary tract infection, there is very little or no abnormality in function or anatomy and physiology of the renal pelvis and calices. There is a suggestion of lobulation of the renal outline.

Impression: Small right kidney in a patient with clinical evidence of urinary tract infection (Fig. 6 and 7).

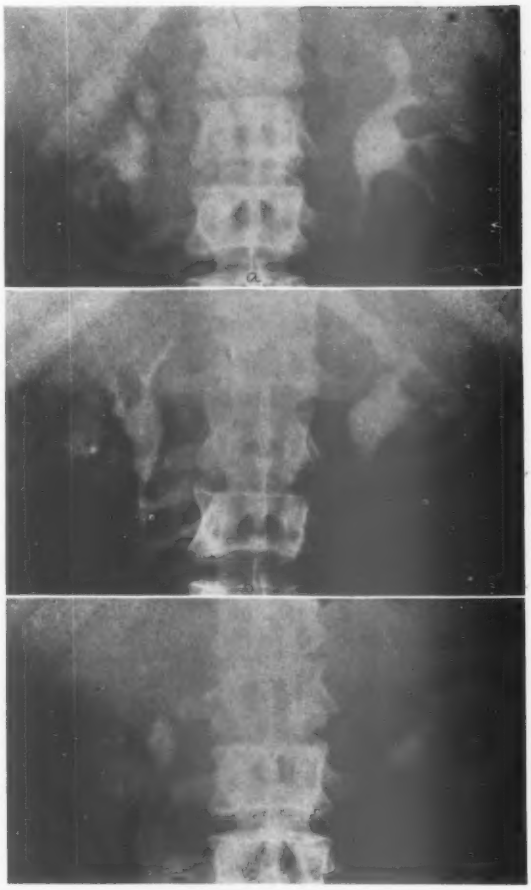

Fig. 6. Case V. Impression: Small right kidney in a patient with clinical evidence of urinary tract infection. Intravenous urograms: (*a*) five minutes, supine; (*b*) ten minutes, Trendelenburg; (*c*) one hour, semi-erect. The right kidney is small. The cortex appears to be preserved and distensibility of the collecting structures retained. There is a suggestion of lobulation of the right kidney outline. No irreversible changes are demonstrated.

Case VI. A white male, aged forty-six, who complained of lower abdominal discomfort. An intravenous urogram was done because a radiopaque density was noted on a survey roentgenogram and a renal calculus was considered possible. The shadow was not present on subsequent examinations and probably was in the gastrointestinal tract. The patient showed no clinical evidence of abnormality of the urinary tract. In the urogram (Fig. 8) the right kidney is small,

FIG. 7. Case v. Retrograde pyelogram in the same case as Figure 6. Other than smallness in size, no abnormality attributable to acquired disease is shown.

but no other evidence of anatomical or physiological abnormality is seen. We have considered this to be as good an example as we have of a hypoplastic kidney.

CASE VII. The patient is a white female, aged forty-five, who was observed over a period of five years for severe hypertension (blood pressure 220/120). No history of urinary tract infection was elicited, nor were there complaints referable to the urinary tract. The blood urea nitrogen was 41 mg. per 100 cc. There was hypertensive retinopathy and generalized arteriosclerosis. A right nephrectomy was performed after the urogram showed a small right kidney (Fig. 9), but the blood pressure remained elevated.

This is one of the important cases in our series. On the basis of the roentgenographic appearance of a small kidney without other evidences of irreversible changes in the collecting structures or marked thinning of the cortex, we would have considered this to be a hypoplastic kidney. The urographic study is not as complete as would be desirable, but the best film (Fig. 9) shows very little abnormality except smallness of the right kidney. Yet the pathological findings after nephrectomy were reported to be those of chronic pyelonephritis, typically so, with superimposed sclerotic changes which were most marked in the zones of scarring.

Impression: Chronic pyelonephritis with a small right kidney in a patient with hypertension and no clinical or urographic evidence of infection (Fig. 9).

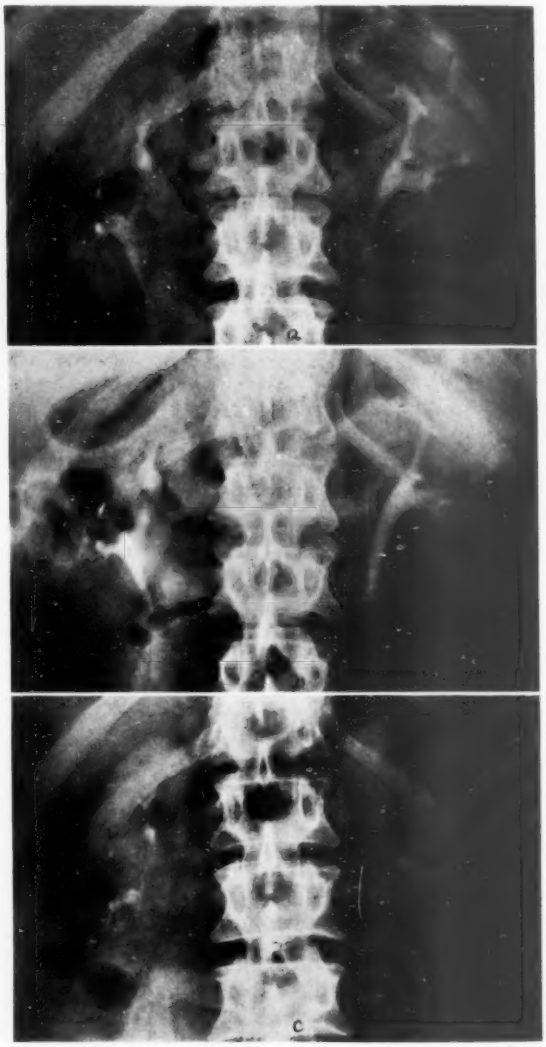

FIG. 8. Case VI. Diagnosis: Probable hypoplastic right kidney. Intravenous urograms: (*a*) five minutes, supine; (*b*) ten minutes, Trendelenburg; (*c*) twenty-five minutes, semi-erect. The right kidney is small, but all functions are preserved and none of the criteria of disease in anatomical or physiological features is shown.

Case viii. A white female, aged eighteen, with a long history of urinary tract symptoms and hypertension (blood pressure 220/160). The history is not definitive, but urinary tract infection was probable. There was retinal arteriosclerosis. The urogram shows a very small right kidney, later removed surgically. The blood pressure remained at a more moderate level after nephrectomy.

The case is shown as one of the smallest kidneys that we have seen. The pathological examination was reported as showing extensive chronic pyelonephritis with secondary contraction.

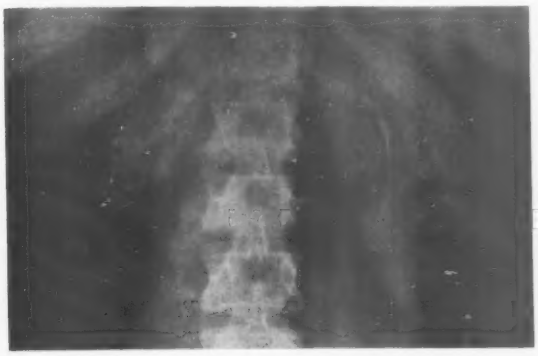

Fig. 9. Case vii. Impression: Chronic pyelonephritis with a small right kidney in a patient with hypertension and no clinical or urographic evidence of infection. Intravenous urogram: fifteen minutes, supine. The right kidney is small, but there is fair function and very little abnormality in the collecting structures. The cortex does not appear to be selectively thinned.

Diagnosis: Atrophic chronic pyelonephritis (Fig. 10).

Fig. 10. Case viii. Diagnosis: Atrophic chronic pyelonephritis, right. (*a*) intravenous urogram; (*b*) retrograde pyelogram. The right kidney is very small and shows diminished function; extensive deformity of the calices, with fixation; marked thinning of the cortex; sharp demarcation of the kidney from the surrounding soft tissues. These changes are in a kidney which showed the pathological appearance of atrophic chronic pyelonephritis.

Case ix. A white male, aged thirty-three, with known hypertension for ten years, slowly rising to a level of 250/170. No history of urinary tract infection was elicited. The patient died in uremia nine months after the urographic examination. The pathological examination of the kidneys was reported as showing evidences of nephrosclerosis and also of chronic pyelonephritis.

This case is a difficult one to interpret from the roentgenographic standpoint, but is in-

Fig. 11. Case ix. Impression: Bilaterally small kidneys in a patient with hypertension. Intravenous urogram: twenty minutes, semi-erect. Both kidneys are small and there is very little dye excretion from either kidney. Pathological examination showed nephrosclerosis and chronic pyelonephritis.

FIG. 12. Case x. Impression: Bilaterally small kidneys in a patient without evidence of referable disease. Intravenous urogram: five minutes, supine. There is prompt dye excretion and no other evidence of abnormality in bilaterally small kidneys. The caliceal detail is not well demonstrated. The renal pelves appear to be intrarenal.

cluded for the appearance of bilaterally small kidney (Fig. 11).

CASE X. A white female, aged sixty-two, with a long history of ill defined gastrointestinal complaints. There was no history or clinical evidence of urinary tract disease. Both of the kidneys are small (Fig. 12). The diagnosis of the clinicians was: "Psychoneurosis with gastrointestinal conversion symptoms." The case is illustrated for the appearance of bilaterally small kidneys in a patient with no other evidence of urinary tract disease or referable systemic disease (Fig. 12).

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ROENTGENOLOGICAL MANIFESTATIONS OF INTRATHORACIC INJURY DUE TO MISSILES

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THIS study is based on observations made in the X-Ray Service of an overseas General Hospital of the United States Army. Four thousand and forty battle casualties were admitted to this hospital in a period of six months and approximately 5 per cent of these had wounds involving the intrathoracic structures. Most of the patients were seen from one to six weeks after being wounded and were observed and treated for several weeks before being returned to duty or evacuated to the zone of the interior. Thus the observations do not cover the acute phase of emergency treatment and rapidly fatal cases nor the late period of convalescence and end result. However, observations during this period give information concerning the result of early treatment and provide a basis for judging the final outcome.

The roentgenological examination of patients with thoracic wounds should determine as far as possible (1) the presence and location of foreign bodies, (2) the extent of bony injuries to the ribs, spine, and sternum, (3) lesions of the lungs, (4) lesions of the mediastinal structures and (5) the status of the pleura and the contents of the pleural space. The conventional exposure of the chest in the posteroanterior projection should be supplemented, as a rule, by lateral and stereoscopic exposures for the localization of foreign bodies and occasionally by roentgenoscopic observation. A technique using some type of grid and an exposure to reveal bone detail is necessary for the detection of rib fractures and the recognition of foreign bodies concealed by the mediastinal structures. If at all possible, the patient should be examined upright with the roentgen rays projected horizontally for the recognition of fluid levels in the lung and pleural cavity and beneath the diaphragm. Thus no single technique will provide a satisfactory examination. Each case presents a roentgenological problem, sometimes requiring considerable ingenuity in the use of the facilities available and in the handling of a seriously ill patient.

Roentgenological manifestations of thoracic injuries are usually multiple but for purposes of classification and study may be divided into groups with the following predominant findings: (1) foreign bodies in the lung, (2) lesions of the pulmonary parenchyma, (3) pneumothorax and hemothorax, (4) lesions and foreign bodies in the mediastinum.

Foreign Bodies. Many cases are seen with metallic fragments lying in the substance of the lung, and in a large proportion of these there is no other evidence of pleural or parenchymal injury. Although the foreign bodies may be large, it is apparent that the rent in the visceral pleura is often promptly sealed with no significant escape of air or blood into the pleural space. Furthermore, foreign bodies may remain in the pulmonary parenchyma with no demonstrable reaction in the adjacent tissues or in their path. One case was observed in which a bullet was lodged in the periphery of the right upper lobe. There was a minimal pneumothorax and the tip of the bullet was in very close proximity to the visceral pleura. At operation, the pleura was seen to be well sealed about the bullet and the adjacent lung appeared normal except for a very mild localized edema. The bullet was easily extracted and there was no escape of blood or pus from the pocket in which it lay. Several foreign bodies have been seen lying close to the mediastinum or hila and it is evident that their progress had been arrested by the greater density of these structures. Undoubtedly instances where the progress was not arrested and perforation of the mediastinal structures had oc-

curred were among the fatal cases that did not come under observation. The question arises as to whether foreign bodies lying close to the mediastinal structures may not in time as the result of pulsations transmitted to them produce a delayed perforation. This hazard must be balanced against the hazard of their operative removal while dormant in considering the advisability of surgical treatment.

Case I. This patient was wounded on February 19, 1945, by a shrapnel fragment in the region of the right shoulder posteriorly. The wound of entrance was over the fifth rib and there was no wound of exit. There was said to have been a hemopneumothorax but the examination (Fig. 1) at this hospital on March 14, 1945, showed no evidence of any pleural involvement. There was comminution of the right fifth rib posteriorly with numerous small metallic fragments at the fracture site. A larger metallic fragment measuring 2.1 by 1.0 by 0.5 cm. had penetrated the right lung and lodged deep in the right hilum near the origin of the right main bronchus. No tissue reaction in the path of the missile or at the hilum was evident.

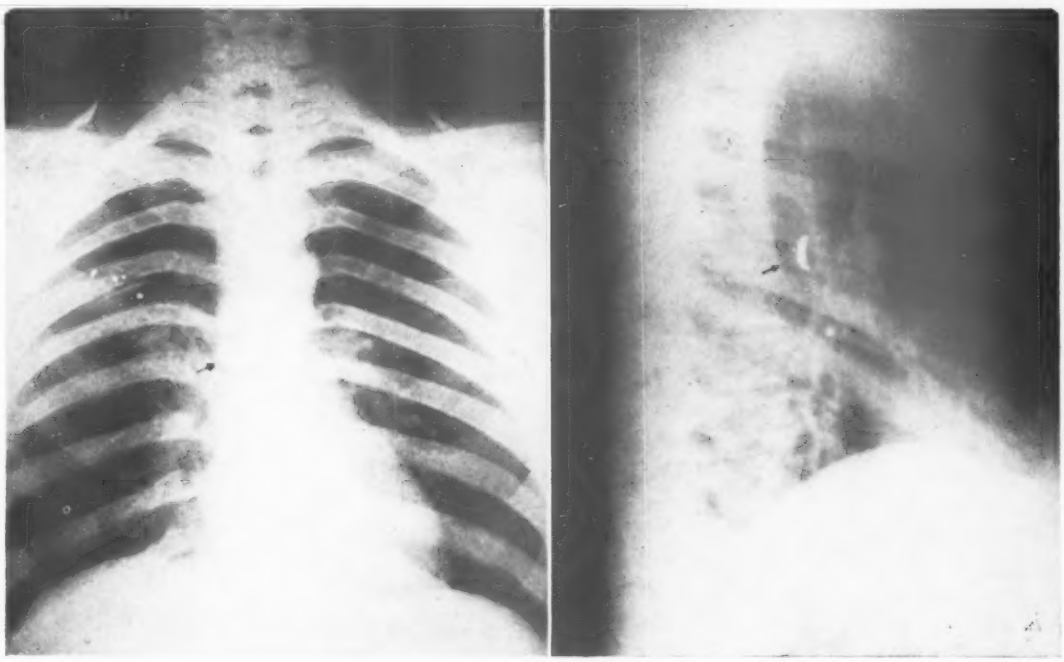

Fig. 1. Case I. Metallic fragment at the right hilum three weeks after injury with no evidence of pleural involvement and minimal pulmonary changes.

Case II. This patient was wounded on December 5, 1944, by a hand grenade, with wounds of entry in the fifth and seventh intercostal spaces in the right posterior axillary line and no wound of exit. There was said to have been a hemothorax on the right but the examination (Fig. 2) here on December 14, 1944, showed no evidence of any pleural involvement or of any infiltration in the lung fields. A metallic fragment measuring 0.9 by 0.8 by 0.6 cm. was observed lying deep in the right lung near the ascending portion of the aorta and the superior vena cava. A smaller metallic fragment lay in the right lateral chest wall.

Traumatic Pneumonia. In several instances, when the pleural manifestations have been transient or absent, an area of infiltration has been observed in the lung. Its location may be correlated with the path of the missile and its behavior follows a constant pattern so that there can be no doubt that the lesion is a traumatic one. The infiltration is at first rather diffuse but soon becomes sharply circumscribed and spherical or ovoid in shape. It slowly di-

minishes in size over a period of several weeks and disappears with minimal residue. The lesion is in all likelihood an area of hemorrhagic infiltration, probably from rupture of a single blood vessel with subsequent clotting, organization, and resolution. The comparatively small size and rarity of these lesions again indicates the high degree of invulnerability of the lung and the improbability of its being a source of serious hemorrhage.

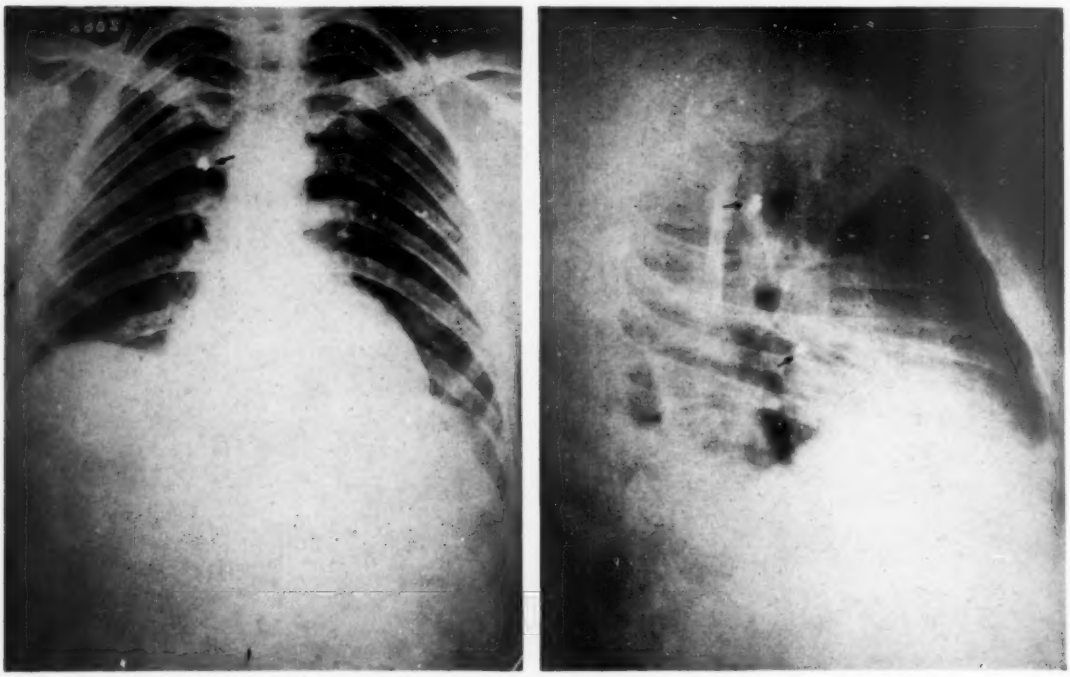

Fig. 2. Case II. Metallic fragment in the right lung nine days after injury with no evidence of pleural or parenchymal involvement.

Case III. This patient was wounded on October 20, 1944. It was thought to have been a gunshot wound but the caliber of the bullet was not known. The point of entrance was in the left chest posteriorly at the level of the sixth and seventh ribs. No point of exit was found. At this hospital the roentgenogram on October 26, 1944, disclosed a small amount of air and exudate in the left pleural space, and infiltration in the left lower lung field. A subsequent study (Fig. 3) on November 5, 1944, showed disappearance of the pleural air and exudate, and the infiltration had assumed an ovoid configuration. It was rather sharply circumscribed and was seen to lie posteriorly in the left lower lobe. The studies on November 13, 20, and 26 showed a gradual decrease in size of the area of infiltration.

Case IV. This patient was wounded on December 30, 1944, by a .25 caliber rifle bullet with the point of entry at the lateral aspect of the upper third of the right arm and the exit was near the inferior border of the right scapula. There were comminuted fractures of the humeral neck, the wing of the scapula, and of the sixth and seventh ribs on the right posteriorly. There was said to have been a hemothorax, but the roentgen examination (Fig. 4) at this hospital on January 21, 1945, showed no evidence of pleural involvement. There was, however, a rounded sharply circumscribed area of dense infiltration in the right lung measuring 4 cm. in diameter and lying at the level of the seventh and eighth ribs posteriorly. At the examination of February 6, 1945, this had decreased to 2.5 by 3.0 cm. in size.

Pleural Manifestations. The most frequent and most serious complications of thoracic injury have been hemothorax and

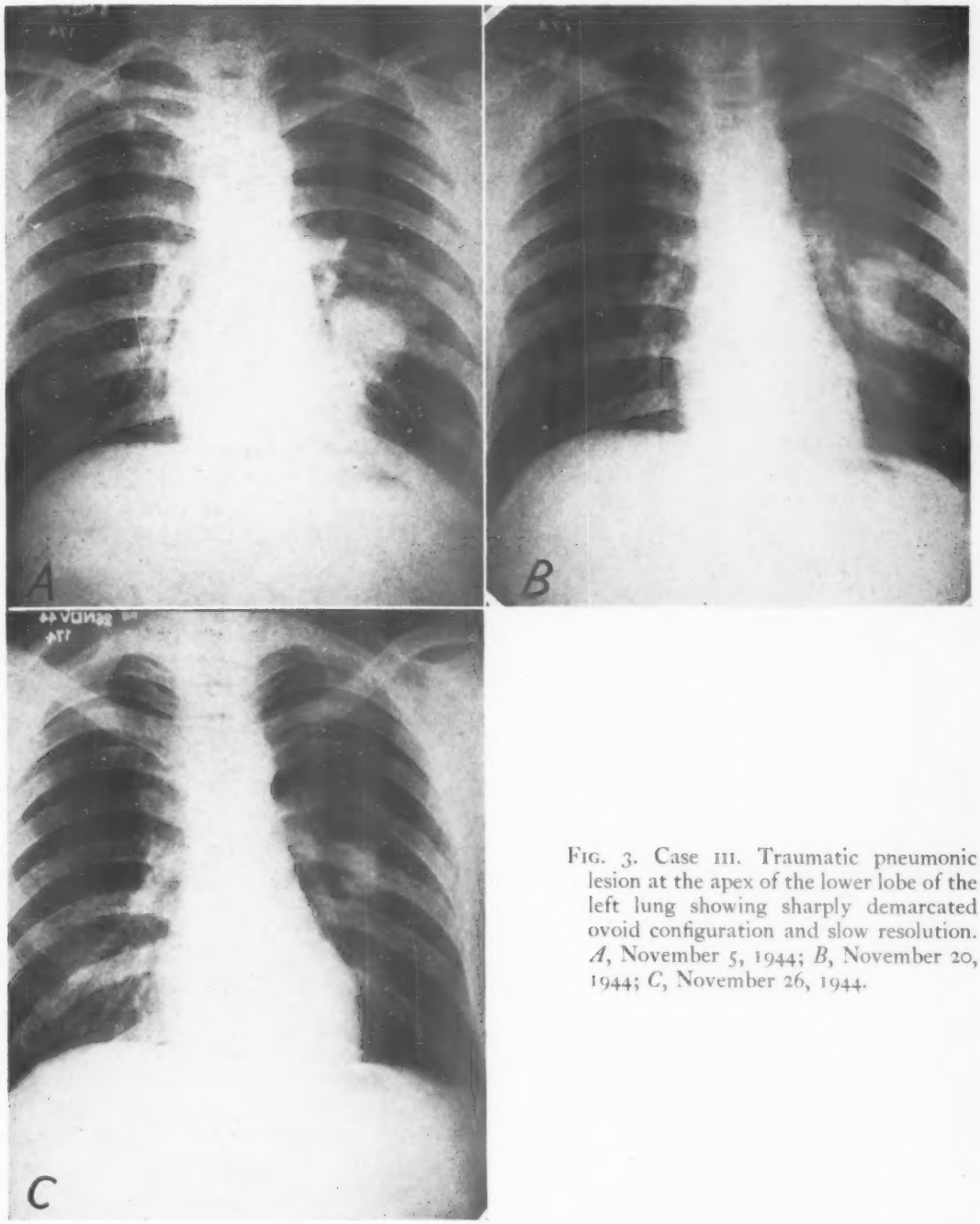

Fig. 3. Case III. Traumatic pneumonic lesion at the apex of the lower lobe of the left lung showing sharply demarcated ovoid configuration and slow resolution. *A*, November 5, 1944; *B*, November 20, 1944; *C*, November 26, 1944.

pneumothorax. Occasionally exudate alone is seen in the pleural space and more rarely a simple pneumothorax, but usually both air and exudate are present together. Under favorable circumstances, the air and exudate will disappear rapidly in two or three weeks after the injury, as in Cases III, V, VI, and XIV. Rapid resolution is more likely when the amount of air and exudate is small and is favored by early and frequent aspiration of the pleural cavity.

Case V. This patient was wounded by hand grenade fragments on October 20, 1944, with points of entrance on the left chest anteriorly. When examined at this hospital on October 26, 1944 (Fig. 5), numerous small metallic frag-

ments were seen in the left chest and there was a moderate amount of air and exudate in the left pleural space. At the study of November 9, 1944, the air had disappeared but a large amount of exudate remained extending over the apex of the left lung. On November 25, 1944, there was no trace of air or exudate and only a slight pleural thickening remained as a residue. There had been almost complete re-expansion of the left lung and a satisfactory recovery could be anticipated.

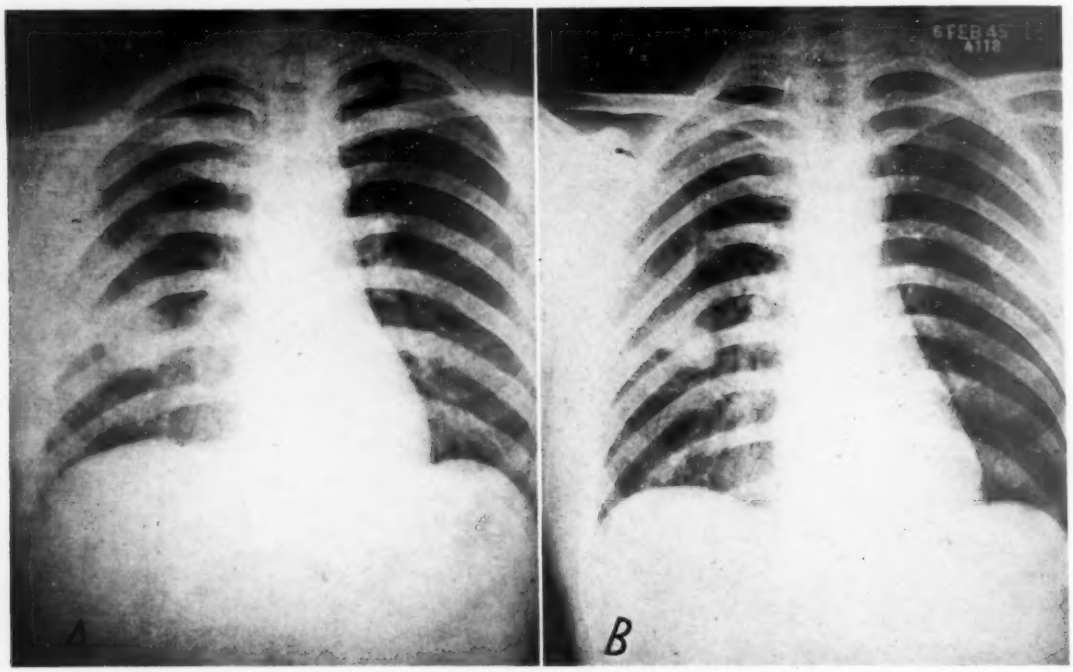

Fig. 4. Case iv. Traumatic pneumonic lesion in the right lung incident to the passage of a rifle bullet. Observations at three and four weeks after injury show a sharply circumscribed dense pneumonic infiltration with tendency to resolution. *A*, January 21, 1945; *B*, February 6, 1945.

Case vi. This patient was wounded January 2, 1945, by a shell fragment and sustained a sucking wound in the neck. The examination of February 13, 1945 (Fig. 6), showed some air in the right pleural space, a small amount of exudate in the right costophrenic sinus, and a slight collapse of the right lung. There was a small metallic fragment in the right upper chest at the level of the third intercostal space posteriorly. The exudate had disappeared at the study of February 22, 1945, and only a small amount of air remained over the upper lobe of the right lung. By March 1, 1945, there was no trace of air or exudate in the pleural space and both lung fields were normally aerated. The patient was discharged to duty, March 20, 1945.

A critical period apparently exists about two weeks after the injury in which it is determined whether resolution of the pleural process is to be rapid and complete or greatly prolonged, as in Cases vii, x, xi and xii, with perhaps irreversible changes established. It is known that blood is a pleural irritant capable of setting up chronic inflammatory changes. The presence of blood in the pleural space produces an outpouring of serofibrinous exudate from the pleural surfaces and later there is the formation of fibrin clots and thickened pleura over a collapsed lung. The amount of pleural exudate may rapidly increase as the result of the pleural irritation and in spite of frequent aspirations (Case vii). Simple aspiration is not effective after the critical period and more radical measures become necessary to evacuate the pleural space. Where the lung has been

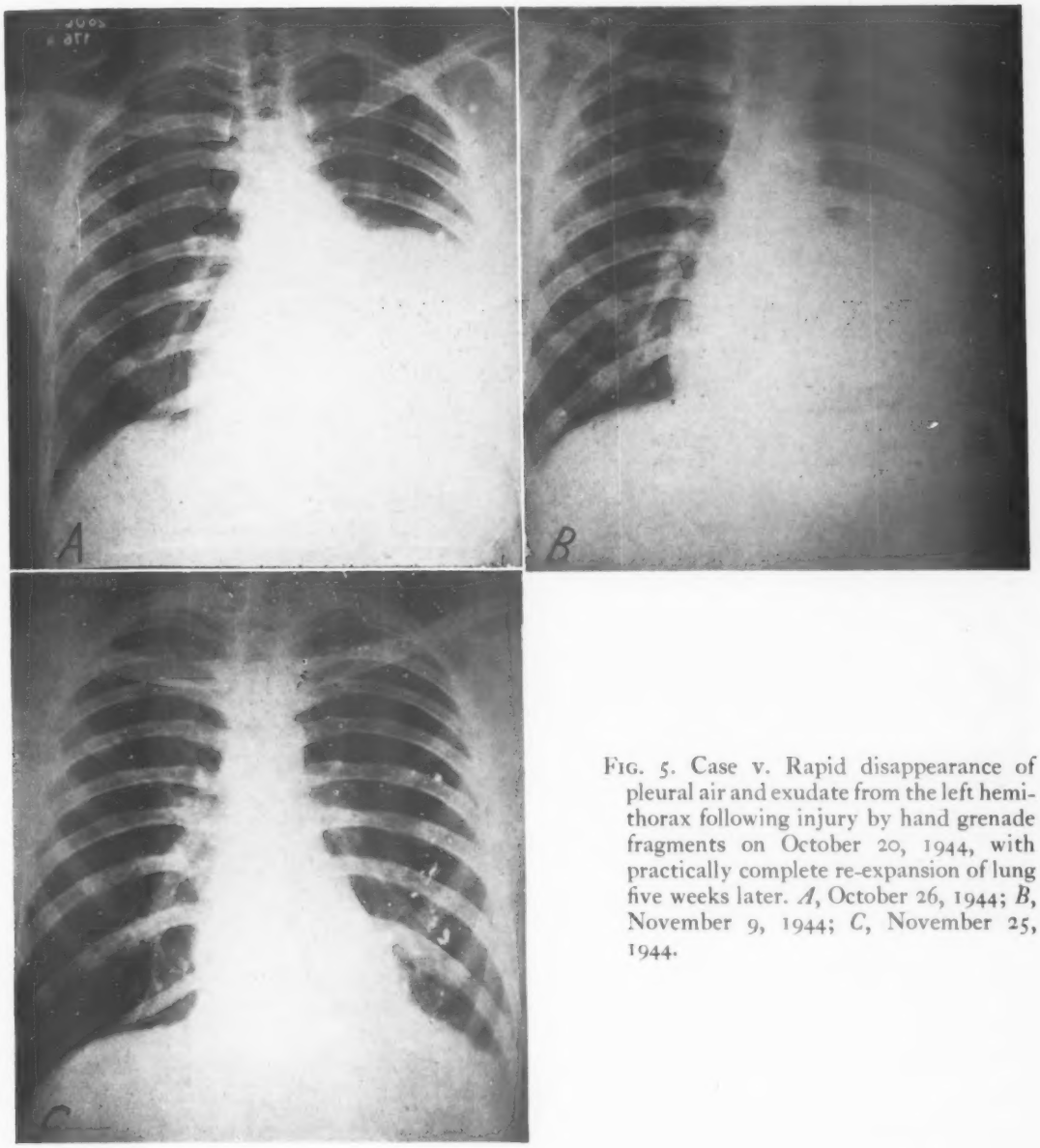

Fig. 5. Case v. Rapid disappearance of pleural air and exudate from the left hemithorax following injury by hand grenade fragments on October 20, 1944, with practically complete re-expansion of lung five weeks later. *A*, October 26, 1944; *B*, November 9, 1944; *C*, November 25, 1944.

collapsed over a long period, as in Cases VII, XI, and XII, it would seem that extensive thoracoplasty may eventually be necessary to close the pleural cavity. In some instances infection is a factor in the chronicity, although in general the manifestations of infection are largely suppressed by the liberal exhibition of penicillin and the sulfonamides. The appearance of the aspirated fluid is often not conclusive and cultures are usually negative as the result of the chemotherapy. Occasionally frank pus is obtained as in Cases X and XII and then there can be little doubt that an actual bacterial infection is present.

A striking observation in these cases was the marked tendency to encapsulation of the pleural contents after the critical period. The encapsulation tended to occur posteriorly in the thoracic cavity, i.e. in the most dependent portion with the patient in a recumbent position. The pocket may be large and single as in Case VIII or there may be numerous small pockets as in Case

ix. In any case, simple aspiration becomes difficult and is usually unsuccessful.

Case vii. This patient was wounded in the left chest posteriorly on December 16, 1944. Roentgen examination at this hospital on January 29, 1945, showed a massive pleural exudate and some air in the pleural space on the left. Attempts to aspirate the pleural space were unsuccessful and on February 19, 1945, a thoracotomy was performed by Lieutenant Colonel Herbert Conway and Major E. E. Lyon. The following is an extract from the operative note: "Opening of the thorax revealed that there was a huge empyema cavity holding approximately 3 quarts of thick yellow brown pus and large clots of fibrin. The fluid was evacuated and the clots were removed by the handful. Inspection of the interior of the cavity revealed that the parietal pleura was $\frac{1}{4}$ inch thick. The pleura was hemorrhagic, yellow to green to red in color. It exuded serous fluid continually as the operation was in progress. Attempts to inflate the lung were unsuccessful due to the thickened visceral pleura." Subsequent examinations made at intervals until the patient was evacuated on April 18, 1945, showed that the lung remained collapsed and both visceral and parietal pleura markedly thickened.

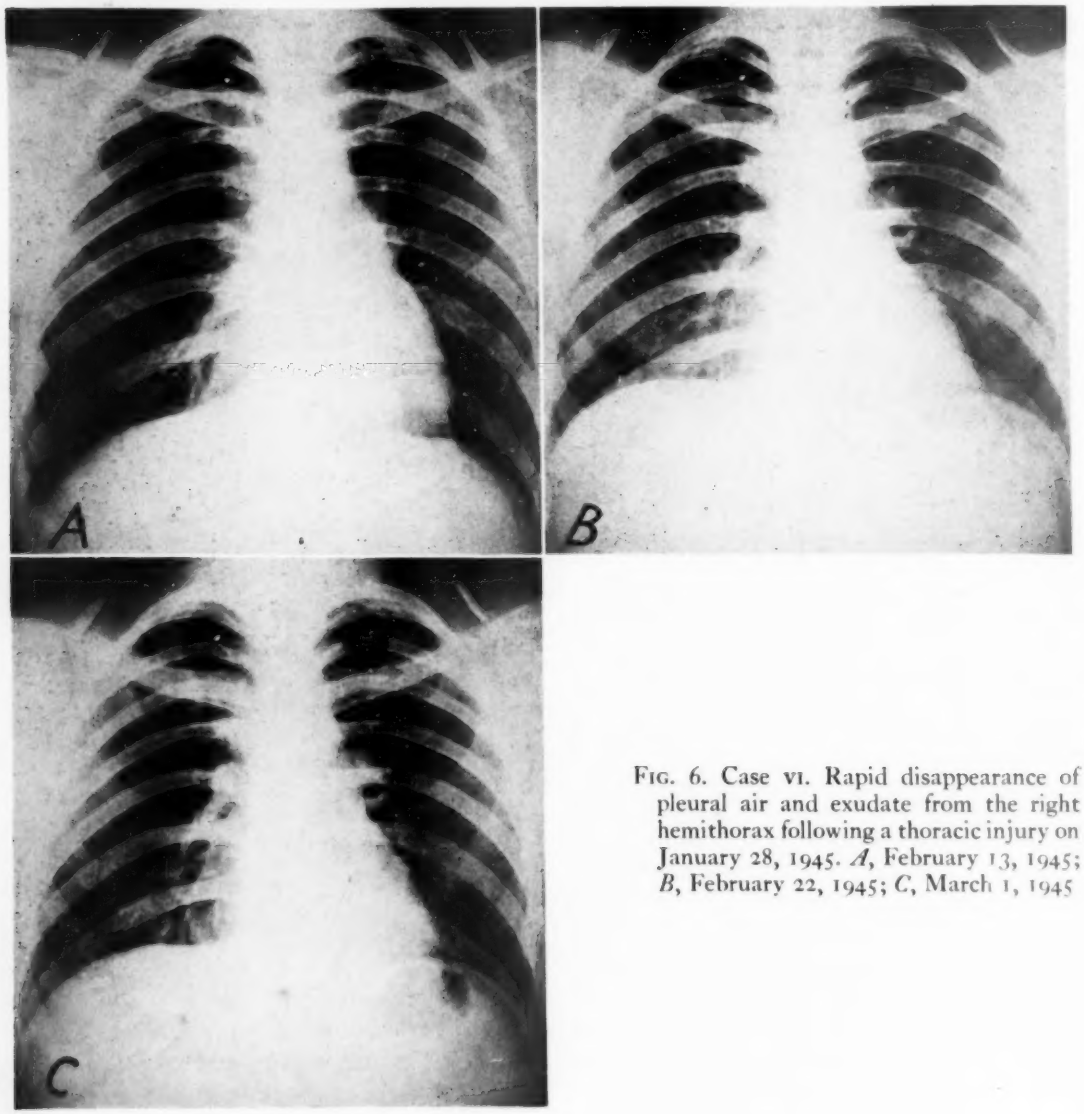

Fig. 6. Case vi. Rapid disappearance of pleural air and exudate from the right hemithorax following a thoracic injury on January 28, 1945. *A*, February 13, 1945; *B*, February 22, 1945; *C*, March 1, 1945

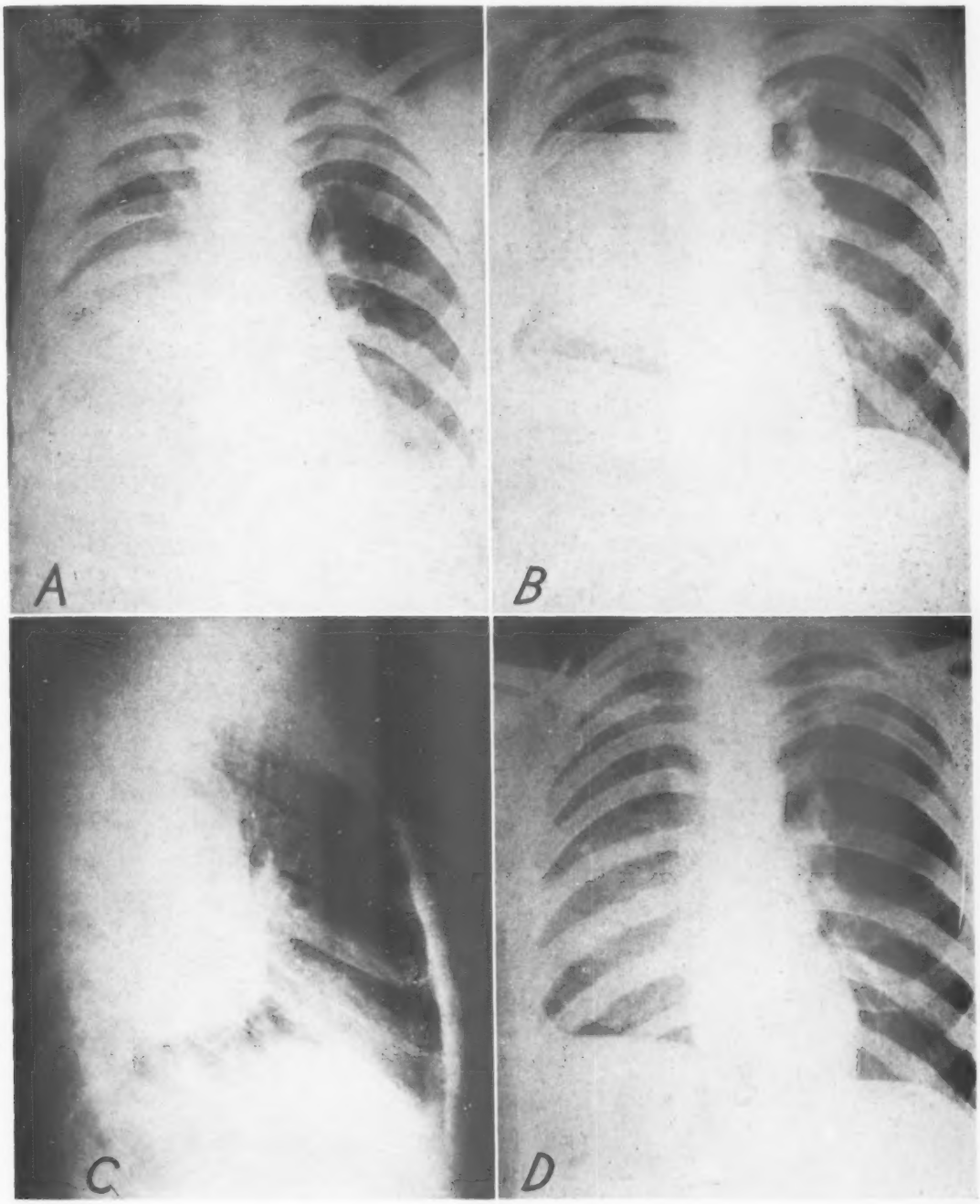

Fig. 7. Case VIII. Large circumscribed encapsulation of air and exudate in the right hemithorax posteriorly with satisfactory response to repeated aspirations. *A*, January 9, 1945; *B*, January 23, 1945; *C*, February 3, 1945; *D*, February 12, 1945.

Case VIII. The history and clinical data of this patient are not available but the case is included as an excellent example of encapsulation of air and exudate in the pleural space. The first roentgen examination (Fig. 7) on January 9, 1945, demonstrated a large hemopneumothorax on the right, a fracture of the ninth rib in the right anterior axillary line, and a shell fragment 7.5 cm. in length lying in the liver shadow in or near the right costophrenic sinus.

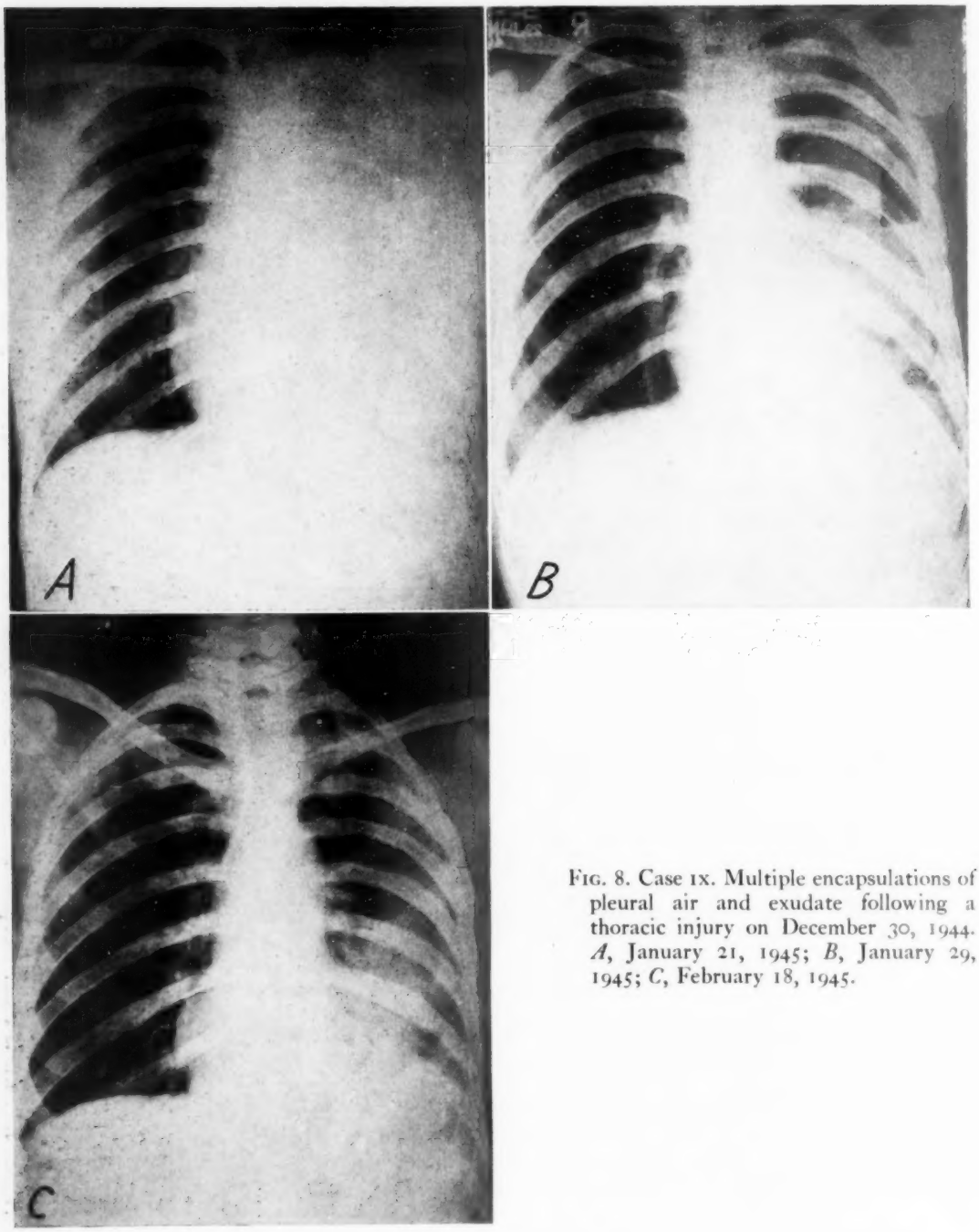

FIG. 8. Case IX. Multiple encapsulations of pleural air and exudate following a thoracic injury on December 30, 1944. *A*, January 21, 1945; *B*, January 29, 1945; *C*, February 18, 1945.

A smaller fragment was seen lying in the right lung at the level of the sixth intercostal space in the posterior axillary line. Operation was performed on January 16, 1945, by Lieutenant Colonel Herbert Conway and the following is an extract from the operative note: "Through the granulating wound in the mid axillary region on the right side the fractured ends of the rib were exposed. These were rongeured away. An exploring instrument easily discovered the large shell fragment. This lay inside the thoracic cage. An exploring instrument showed that the cavity extended anterior and medial and apparently did not communicate with the pleural cavity." The first attempts to aspirate the pleural space at the usual site low in the pos-

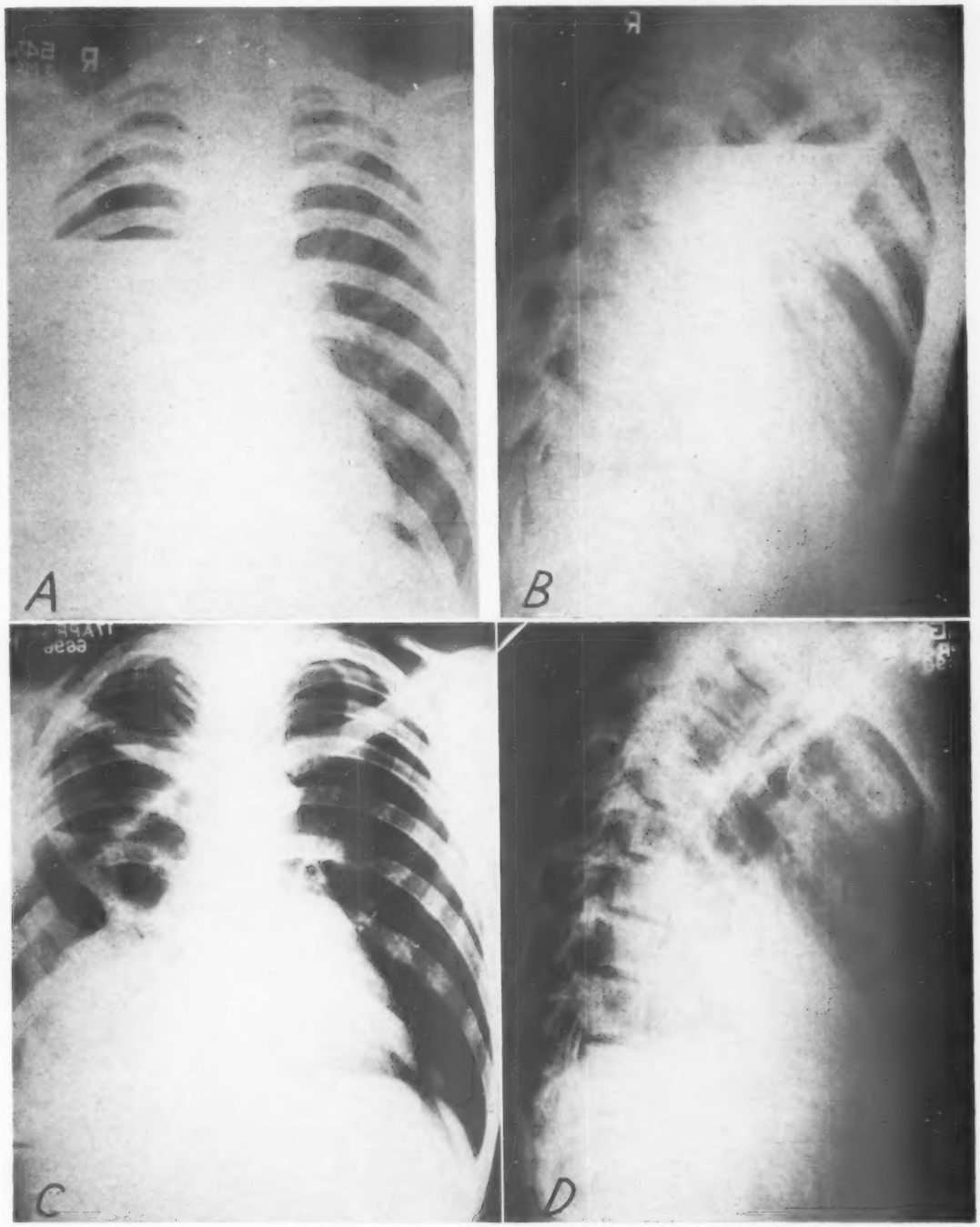

Fig. 9. Case x. Large encapsulation of air and exudate in the right upper chest posteriorly with a bronchopleural communication demonstrated at operation. *A*, *B*, March 8, 1945; *C*, *D*, April 17, 1945.

terior axillary line were not successful and exudate was not obtained until thoracentesis was performed at a higher level and further posteriorly. The roentgenogram on February 3, 1945, shows the large circumscribed encapsulation of air and exudate lying posteriorly in the right chest. With repeated aspirations of this cavity it diminished gradually in size so that only a small amount of air and exudate remained at the last study on February 12, 1945.

Case ix. This patient sustained a penetrating

bullet wound of the back at the level of the tenth dorsal vertebra on December 30, 1944. The roentgenogram of January 21, 1945 (Fig. 8) showed a massive pleural exudate on the left. The subsequent films on January 29, 1945 and February 18, 1945, show numerous fluid levels in the left chest indicating multiple small encapsulations of air and exudate in the pleural space.

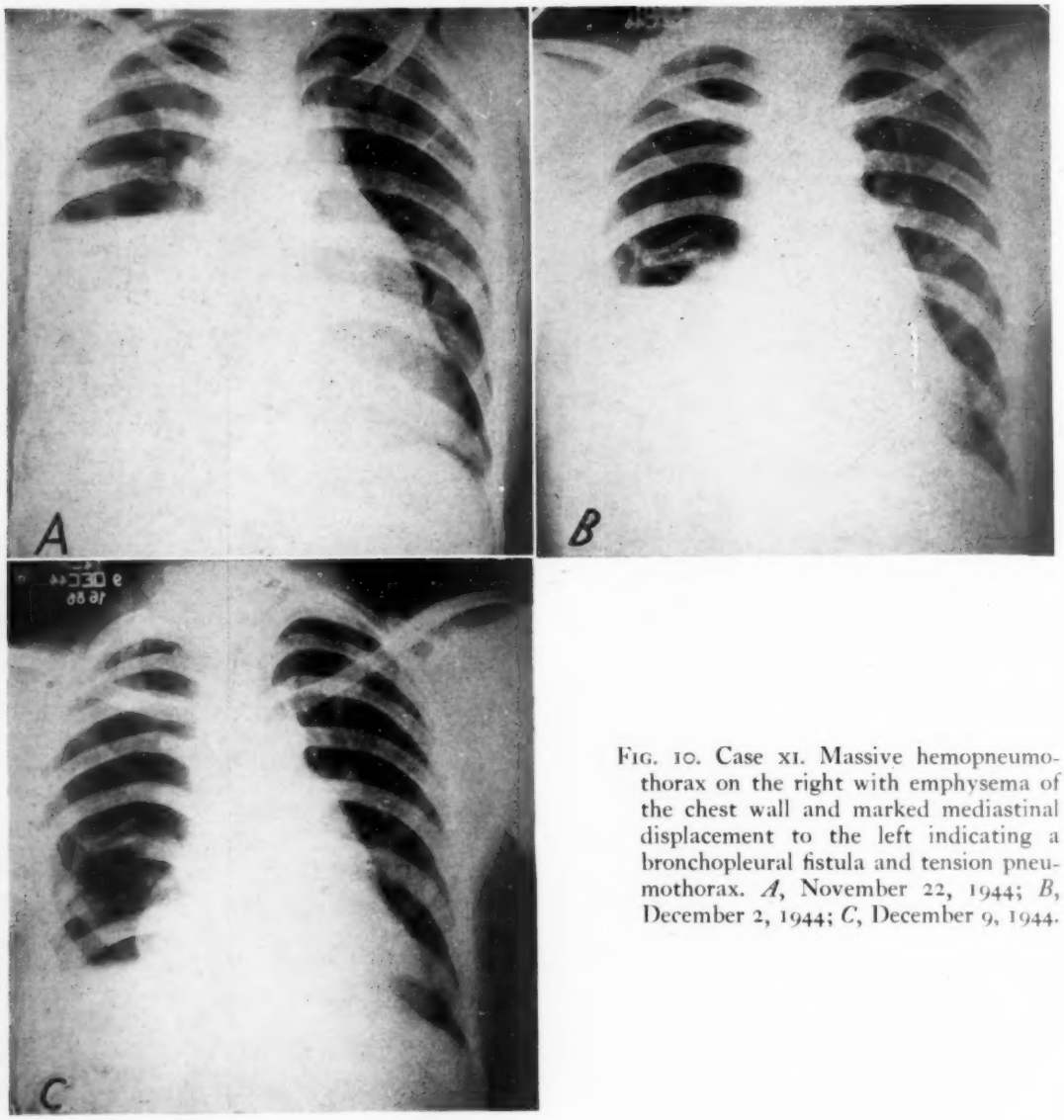

Fig. 10. Case xi. Massive hemopneumothorax on the right with emphysema of the chest wall and marked mediastinal displacement to the left indicating a bronchopleural fistula and tension pneumothorax. *A*, November 22, 1944; *B*, December 2, 1944; *C*, December 9, 1944.

Case x. This is another example of encapsulated pleural exudate. The posteroanterior and lateral roentgenograms of March 8, 1945 (Fig. 9) demonstrate a massive accumulation of air and exudate in the right pleural space with a large encapsulation in the upper chest posteriorly. Attempts at simple aspiration of the pleural space were not successful. Operation was performed by Lieutenant Colonel George Plain on March 18, 1945, and the following is an extract from the operative note: "The large abscess of the right chest wall was incised. There was a large amount of skin undermined so that wide incision was necessary. The tract into the pleural cavity was then exposed and dependent drainage established for the lower collection of pleural exudate. The index finger was then passed upward in the posterior aspect of the pleural cavity in an attempt to reach the collection in this region. As the soft tissue was

touched the patient immediately stopped breathing and expectorated large volumes of yellow pus. No further attempt could be made because of the precarious state into which the patient immediately fell." The encapsulation of air and exudate in the upper chest posteriorly persisted as indicated in the studies of March, 29, 1945, and April 17, 1945, although there was diminution in the size of the cavity.

A careful scrutiny of the soft tissues of the chest wall may give evidence of an interstitial emphysema or abscess formation as in Cases XI and XII. When air escapes from the lung into the pleural cavity, a tension pneumothorax results with the pressure in the pleural space rising and eventually exceeding the atmospheric pressure. The comparative rarity of this phenomenon is further evidence of the rapid healing of lesions of the visceral pleura. With a tension pneumothorax, the air may escape through a rent in the parietal pleura and produce an interstitial emphysema of

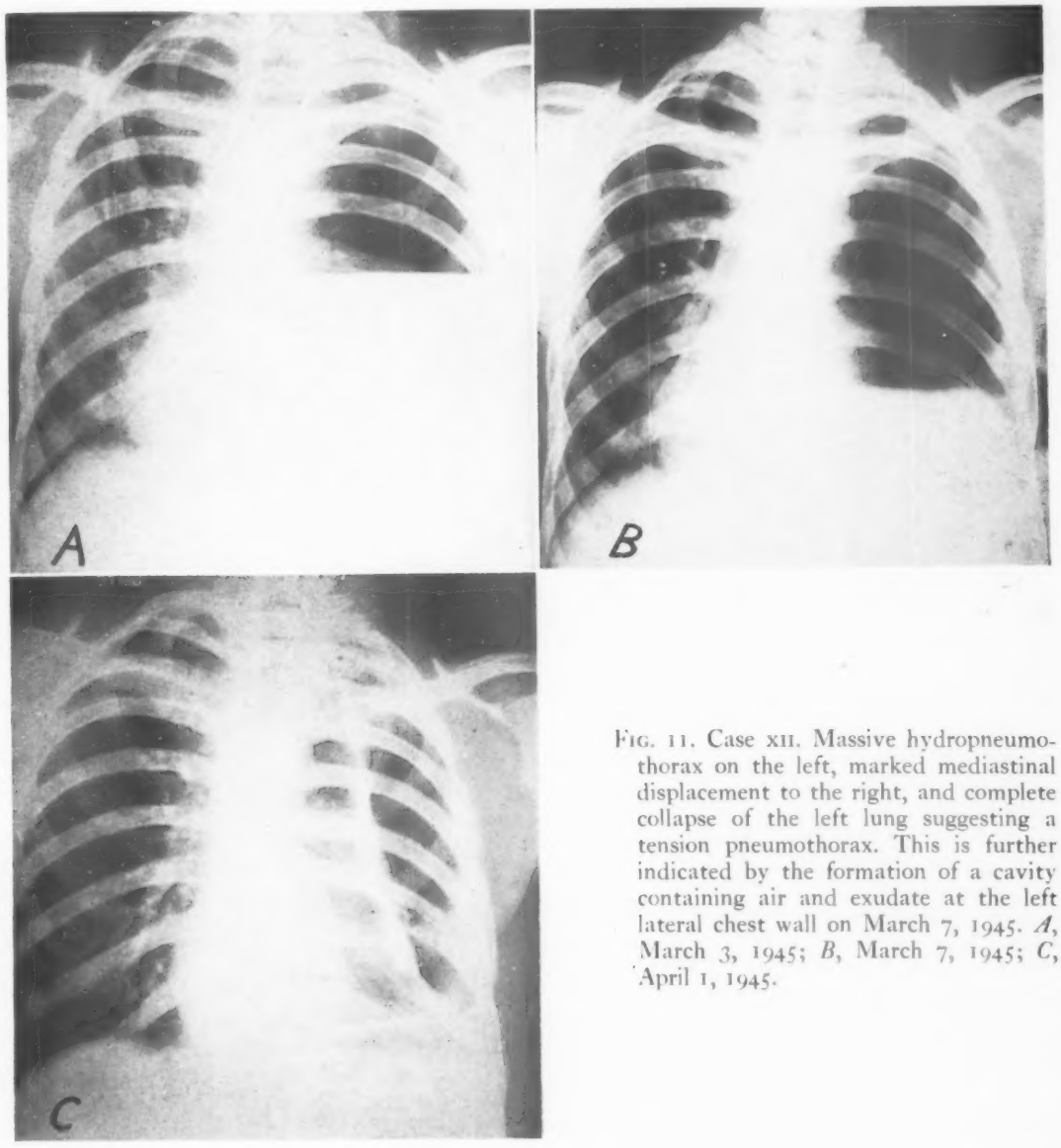

FIG. 11. Case XII. Massive hydropneumothorax on the left, marked mediastinal displacement to the right, and complete collapse of the left lung suggesting a tension pneumothorax. This is further indicated by the formation of a cavity containing air and exudate at the left lateral chest wall on March 7, 1945. *A*, March 3, 1945; *B*, March 7, 1945; *C*, April 1, 1945.

the chest wall as was observed in Case xi. A complete collapse of the lung and a marked displacement of the mediastinum are also strongly indicative of a tension pneumothorax as in this case. A marked displacement of the mediastinum was not otherwise observed even in cases of massive hemopneumothorax. If the intrapleural pressure is high due to a tension pneumothorax and the rapid accumulation of pleural exudate and if infection is present, both air and exudate may escape from the pleural space into the tissues of the chest wall producing cellulitis and abscess formation as in Cases x and xii. The demonstration of a bronchopleural fistula at operation in Case x is further evidence of a tension pneumothorax in this instance.

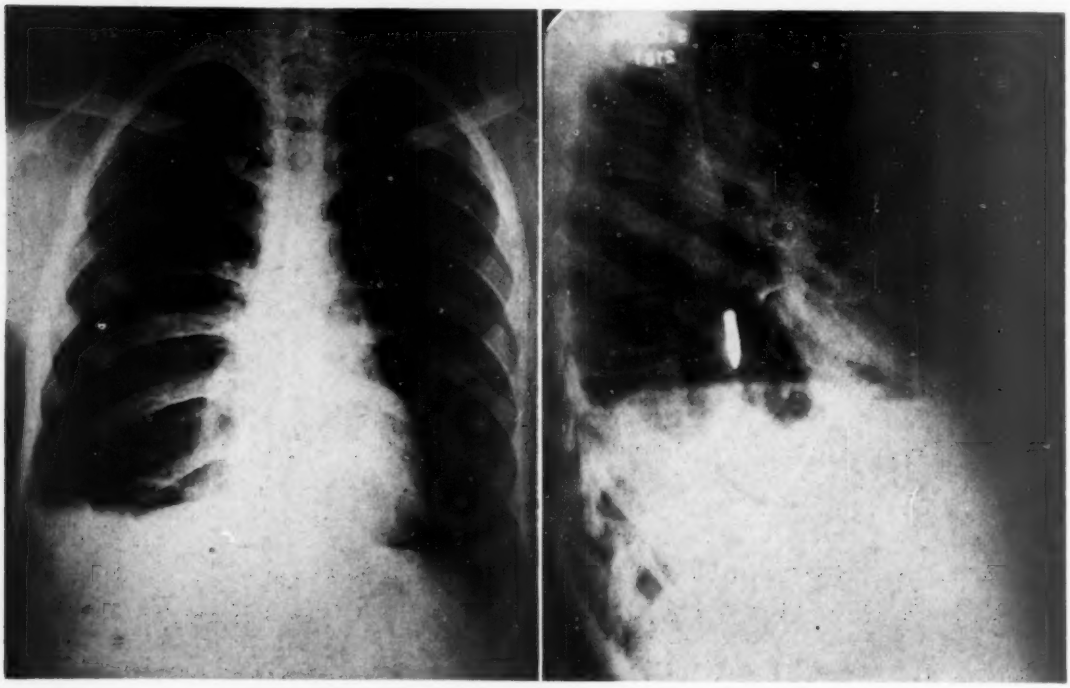

Fig. 12. xiii. A .25 caliber bullet lying in the mediastinum in close proximity to the right border of the heart, descending aorta, inferior vena cava and esophagus. Removal was not attempted.

Case xi. This patient was wounded October 28, 1944, by a .25 caliber bullet sustaining a severe laceration over the right scapula. At the first roentgen study on November 22, 1944, at this hospital (Fig. 10) there was a massive hemopneumothorax on the right with almost complete collapse of the right lung and an extensive interstitial enphysema of the chest wall and supraclavicular tissues. The air disappeared from the chest wall and large quantities of pleural exudate were removed but the right lung remained collapsed as shown by the last study on December 9, 1944.

Case xii. This patient sustained a gunshot wound on January 30, 1945, with a point of entrance in the left mid axillary line and a point of exit in the left flank. The first roentgenogram at this hospital on March 3, 1945 (Fig. 11) showed a massive hydropneumothorax on the left, complete collapse of the left lung, a marked displacement of the mediastinum to the right and soft tissue swelling at the left lateral chest wall. At several aspirations in February and on March 4, 1945, quantities of straw colored fluid were removed but the aspiration of March 6, 1945, yielded 750 cc. of "thick green pus." The roentgenogram of March 7, 1945, showed an air-containing cavity with a fluid level at the left lateral chest wall indicating an extension of the empyema into the tissues of the chest wall with abscess formation. Following drainage of

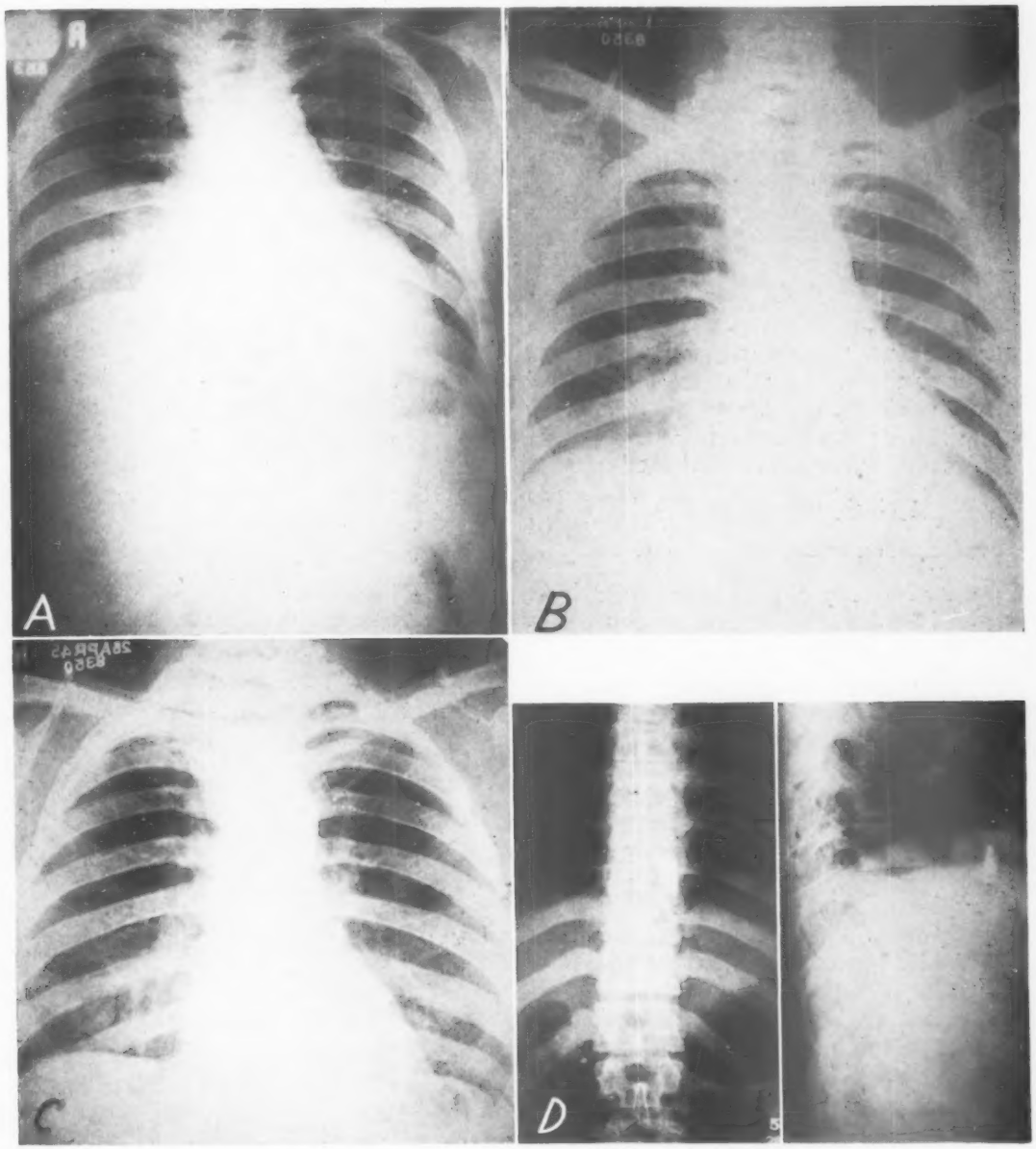

Fig. 13. Case xiv. Large cardiac shadow probably representing pericardial effusion observed eleven days after a bullet wound. The bullet is demonstrated in the posterior lower mediastinum near the posterior border of the heart. At operation the bullet was located in the wall of the heart and successfully removed. *A*, March 22, 1945; *B*, April 1, 1945; *C*, *D*, April 25, 1945.

the abscess and empyema cavities, there was a partial re-expansion of the left lung but a rather marked thickening of the visceral pleura as indicated in the last study of April 1, 1945.

Mediastinal Involvement. Cases with foreign bodies in the mediastinum have been rare and it would seem that the large majority of these cases are rapidly fatal from hemorrhage. The decision to attempt removal of the foreign bodies in patients who survive is a matter requiring great experience and careful surgical judgment. Exploration of the mediastinum is difficult and hazardous at best. On the other hand, foreign bodies may not remain quiescent in the mediastinum. Instances have been

observed where there has been a late perforation of a large vessel apparently as the result of slow erosion produced by vascular pulsation. The finding of a large cardiac shadow in a case of thoracic injury should raise the suspicion of a pericardial effusion.

Case xiii. This patient was wounded on November 19, 1945, when a .25 caliber bullet penetrated the chest just to the right of the seventh dorsal vertebra. Posteroanterior and lateral roentgenograms (Fig. 12) on December 3, 1945, showed the bullet lying in the chest posterior to the right border of the heart and therefore in close proximity to the descending aorta, the esophagus and the inferior vena cava. A small amount of air and exudate were present in the right pleural space but no lesion was demonstrable in the right lung. The patient was evacuated on December 16, 1945.

Case xiv. This patient was wounded by a bullet on March 11, 1945, with a point of entrance near the eleventh rib in the right posterior axillary line and no wound of exit. On March 11, 1945, 550 cc. of bloody fluid was aspirated from the right pleural space. A roentgenogram made on March 22, 1945 (Fig. 13) at a forward hospital showed a small amount of exudate remaining and a markedly enlarged cardiac shadow. The roentgen study at this hospital on April 1, 1945, again showed a very large cardiac shadow but the pleural exudate had disappeared. On April 25, 1945, the cardiac shadow had returned to within normal limits of size and configuration and it seemed likely that the previous enlargement had been due to a pericardial effusion. Up to this point the foreign body had not been demonstrated and a search was therefore made of the mediastinal area with a more penetrating exposure. The foreign body was found lying just to the left of the midline near the posterior surface of the heart and anterior to the ninth dorsal vertebra. This was confirmed roentgenoscopically, and the foreign body was seen to move synchronously with the ventricular beat and to be anterior to the barium-filled esophagus. Operation was performed on May 1, 1945, by Lieutenant Colonel Herbert Conway and Major Kenneth Coldwater. The following is an abstract from the operation report: "At operation the posterior thoracic extrapleural approach of Lilienthal was used. The vertical portion of the incision was just over the margin of the erector spinae muscle on the left and the transverse portion of the incision parallel to the ninth rib. The foreign body could be felt just anterior to the esophagus approximately 1 cm. above the esophageal hiatus. Just before operation, a large sized stomach tube had been passed. This aided in the identification of the esophagus and the location of the foreign body. The pericardium was then opened and it was found that the foreign body, which was a misshapen .31 caliber machine gun bullet, was in the wall of the heart at the junction of the right auricle and ventricle on its under side at the point where the pericardium fuses with the diaphragm. The missile was gradually extracted and there was no hemorrhage."

CONCLUSIONS

1. Foreign bodies are frequently seen in the lung with very little or no evidence of reaction in the lung or pleura. Many are arrested by the denser tissues of the hilar and mediastinal structures.

2. Traumatic lesions in the lung tend to be small, well circumscribed, and to undergo uneventful resolution.

3. Small amounts of air and blood in the pleural space are rapidly absorbed. Early and frequent aspirations of the pleural space favor a rapid resolution.

4. Blood in the pleural space is an irritant leading to exudation from the pleura, the formation of large fibrin clots and a thickening of the pleura. The exudate tends to become encapsulated posteriorly, often in multiple pockets. It may become infected even when patients are given sulfonamides and penicillin. Early and complete removal of the blood is indicated in the first ten days following the injury. Later irreversible changes occur and convalescence is greatly prolonged.

5. Foreign bodies occasionally lodge in the mediastinum and escape detection by roentgen examination unless exposures of sufficient penetration are used. A large cardiac shadow observed in patients with missile injuries of the thorax suggests that there has been involvement of the pericardium with the formation of a pericardial effusion.

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PULMONARY CAVITIES "BELOW THE DIAPHRAGM"

A PHENOMENON SOMETIMES SEEN IN PNEUMOPERITONEUM TREATMENT OF PULMONARY TUBERCULOSIS*

By PHILIP MORGENSTERN, M.D., *and* IRVING PINE, M.D.

IN SOME parts of the country pneumoperitoneum with or without phreniclasia is rapidly replacing pneumothorax in the treatment of pulmonary tuberculosis with cavitation, particularly if the disease is bilateral. A recent article reports as high as 57 per cent closure of cavities, both in basal disease and in upper lobe involvement.

During the past few weeks we have had occasion to observe two patients with apparently successful pneumoperitoneum whose sputum nevertheless remained persistently positive for tubercle bacilli. Conventional posteroanterior chest roentgenograms showed a good rise of the diaphragm to well above the level of the original cavity. No suspicious highlights could be identified in any portion of the lung fields. However, careful roentgenoscopy and special views revealed residual highlights to be still present, but wedged in between the sharply sloping diaphragm and the chest wall. In other words, these highlights were situated well below the dome of the diaphragm in the anterior and posterior sulci where they would not ordinarily be looked for. Pneumoperitoneum had merely elevated the central portion of the dome, but had not affected the periphery, so that the pathology seemed to be "below the diaphragm." A third case is also reported where a patient had a giant cavity involving practically the entire right lower lobe. Right phreniclasia and pneumoperitoneum were done at another institution, but failed to close the huge excavation. Here there was no difficulty in visualizing the giant cavity on conventional posteroanterior roentgenograms, but the phenomenon of "cavity below the diaphragm" was again well illustrated and the lateral view brought out the mechanism of this seeming paradox.

REPORT OF CASES

CASE I. M.R.V., a WAVE veteran, aged twenty-four, was first diagnosed as far advanced pulmonary tuberculosis in September, 1943. She was admitted to Veterans Administration Hospital, Oteen, in October, 1944, where left phreniclasia was instituted in November, 1944, followed two months later by pneumoperitoneum. In April, 1945, she developed an extensive caseous pneumonic spread into the right lower lobe and pneumoperitoneum was abandoned due to the toxic condition of the patient. Cavitation appeared in the right hilar region after resolution of the caseous pneumonic process. In May, 1946 right phreniclasia and pneumoperitoneum were reinstituted in an attempt to close the cavity. By August, 1946, the cavity could no longer be seen on the posteroanterior view, but sputum was persistently positive and physical examination showed numerous medium moist rales at the right base posteriorly. Roentgenoscopic study revealed a large highlight with basal fluid level situated in the field of the pneumoperitoneum below the dome of the diaphragm. It was well seen on the anteroposterior roentgenogram, although the posteroanterior view had failed to reveal it. Apparently it represented a compressed cavity in the posteromedial portion of the right lower lobe (Fig. 1, 2 and 3).

CASE II. T. W. M., a Navy nurse veteran, aged twenty-nine, was admitted to Veterans Administration Hospital, Oteen, in December, 1944, with a large tuberculous cavity at the right hilum. Pneumothorax failed to close the cavity and was abandoned after five weeks. In April, 1946, right phreniclasia was performed followed three weeks later by pneumoperitoneum. The cavity in the right lung was no

* From the Department of Medicine and Surgery, Veterans Administration, Oteen, North Carolina. Published with permission of the Chief Medical Officer, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the authors.

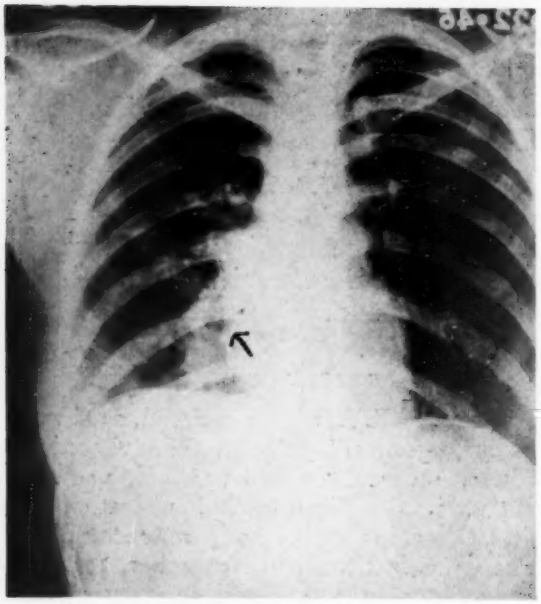

FIG. 1. Case 1. Posteroanterior roentgenogram of the chest in May, 1946, showing residual hilar cavity adjacent to the right cardiac border.

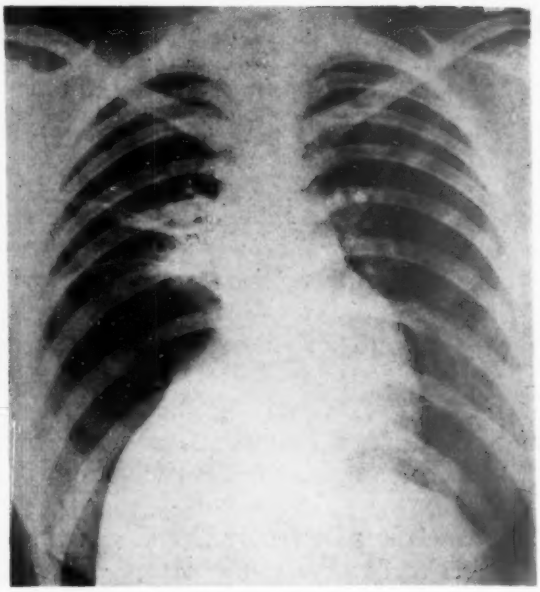

FIG. 2. Case 1. Posteroanterior roentgenogram of the chest several months after right phreniclasia and pneumoperitoneum. No cavity is visible but sputum was persistently positive for tubercle bacilli.

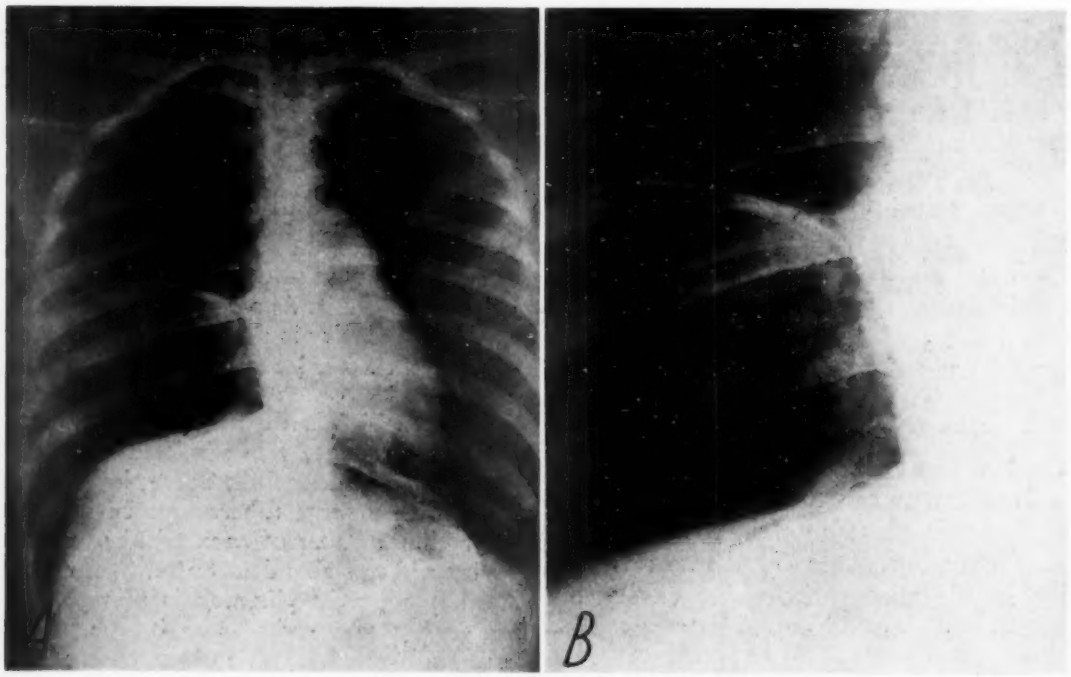

FIG. 3. Case 1. *A*, anteroposterior view of the chest showing definite cavity with fluid level in the pneumoperitoneum field "below the diaphragm." *B*, close-up view of cavity "below the diaphragm" seen in *A*.

longer apparent, but the sputum persisted positive for tubercle bacilli and auscultation revealed a few medium moist rales at the right base anteriorly and posteriorly. Roentgenoscopic examination revealed a large highlight in the pneumoperitoneum field below the dome of the diaphragm. It was anterior to the heart in the anteromedial portion of the right lung base and could be well demonstrated only in a left anterior oblique position. Its very thin wall suggested some type of air-containing cyst but the possibility of its being a tuberculous cavity could not be ruled out (Fig. 4 and 5). Exploratory thoracotomy and partial lobectomy were done on February 7, 1947. The highlight noted in the roentgenogram was found to be caused by a large emphysematous bleb about 4 cm. in diameter arising from the lingula of the right upper lobe. Within the lingula was a caseous area with central necrosis which had apparently been the source of the positive sputum.

Fig. 4. Case II. Posteroanterior roentgenogram of the chest several months after right phreniclasia and pneumoperitoneum. Sputum persistently positive, but no definite cavity is visualized.

Case III. R. G., an Army veteran, aged twenty-five, whose tuberculosis began in October, 1945, with a pneumonic process involving the right lower lobe. Since then he had run a persistently febrile course and an excavation developed which grew progressively larger and soon involved almost the entire right lower

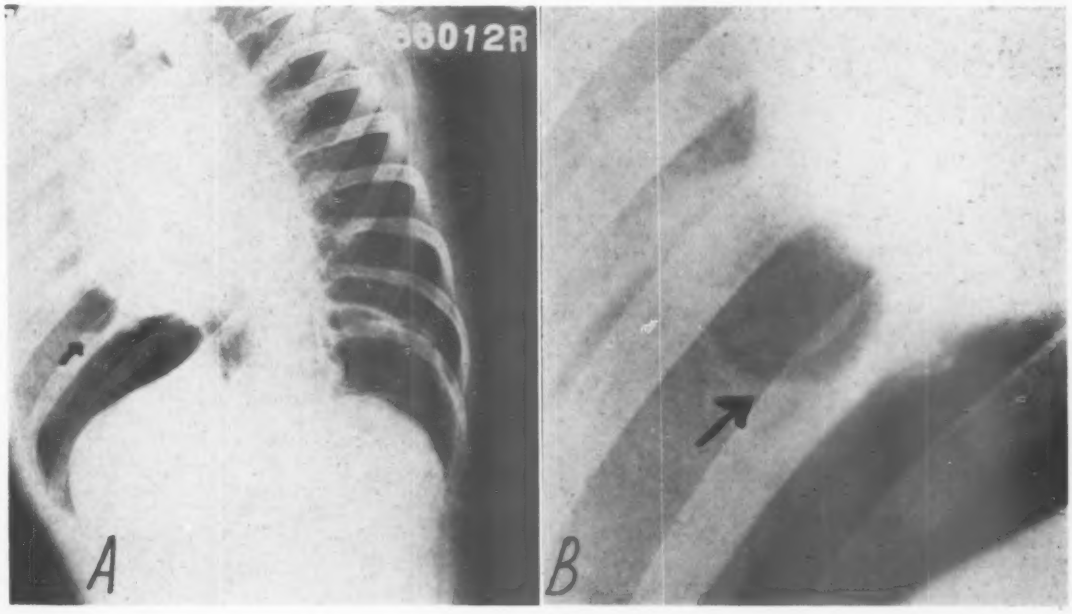

Fig. 5. Case II. *A*, left anterior oblique view showing large highlight in anteromedial portion of right lung base below the level of the diaphragm. *B*, detailed view of large highlight seen "below the diaphragm" in *A*.

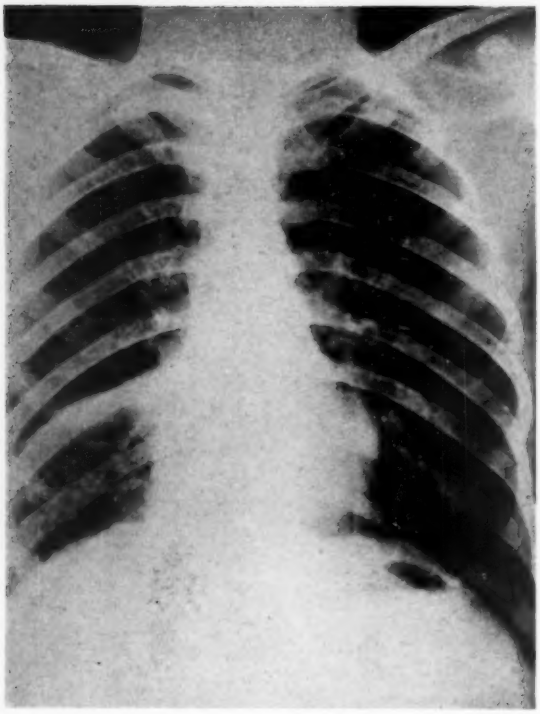

FIG. 6. Case III. Large cavity involves practically entire right lower lobe and there is some bronchogenic spread to the left mid-lung field.

lobe. Right phreniclasia was performed at another institution on November 29, 1946, followed by pneumoperitoneum four days later. He was transferred to Oteen on December 12, 1946, for cavernostomy. Roentgen examination of the chest showed a pneumoperitoneum with the right diaphragm elevated to the level of the fourth anterior interspace. A giant cavity occupied almost the entire right lower lobe and more than half of it extended below the diaphragm. Right lateral views showed that the pneumoperitoneum had merely elevated the anterior portion of the diaphragm while the posterior segment showed no appreciable rise with no effect on the large lower lobe cavity (Fig. 6 and 7).

DISCUSSION

It should not be concluded from these cases that all cavities in the lower lung field follow the pattern outlined above. On the contrary, in most cases of basal or hilar lesions treated with pneumoperitoneum, the cavity either closes promptly or else the open cavity is clearly seen above the dome of the diaphragm. In a small

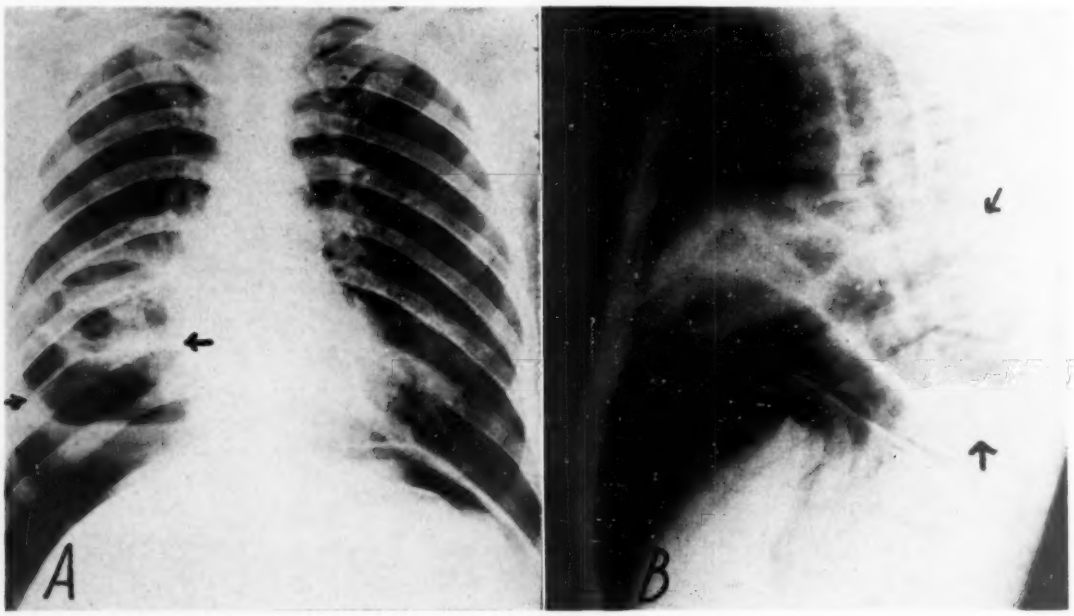

FIG. 7. Case III. *A*, posteroanterior roentgenogram of the chest following induction of right phreniclasia and pneumoperitoneum. The right diaphragm is indicated by arrows and a large portion of the cavity is seen "below the diaphragm." *B*, right lateral view showing how the anterior portion and dome of the diaphragm have been elevated while the posterior portion is only slightly affected with the result that a large portion of the cavity is seen "below the diaphragm." Borders of the cavity are indicated by arrows.

percentage of such cases, however, where the lesion is situated in a portion of lung close to the pleura and locally adherent to the chest wall with perhaps an intermittent obstruction of the regional branch bronchus, the series of events outlined above may occur. It will then be necessary to search for residual cavities in those portions of the lung which dip down below the dome of the diaphragm. One must keep in mind also that cavities in such locations may not show the usual clear delineation because of the fact that we have two layers of diaphragm superimposed on the shadow of the cavity.

One further point may be of some practical value. Where phreniclasia alone has been used for a right lower lobe cavity, and the sputum is persistently positive, a residual cavity may be obscured by the shadow of the liver. In such a case, the addition of a pneumoperitoneum may provide a sufficiently contrasting background to help locate the cavity.

SUMMARY

(1) In the pneumoperitoneum treatment of pulmonary tuberculosis of the lower lobes, it may be necessary to look for residual cavities in those portions of the lung that dip into the anterior and posterior sulci.

(2) The mechanism of pulmonary cavitation "below the diaphragm" is discussed and three illustrative cases are presented.

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GASTRIC TUBERCULOSIS

A CASE REPORT

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THE criteria for the diagnosis of gastric tuberculosis were provided by Broders,[1] in 1917. The requirements were grouped into (*a*) positive cases in which the pathologic picture was typical, plus demonstration of the tubercle bacillus in the tissues; (*b*) probable cases in which the lesions were typical, and (*c*) possible cases in which there was a good description of the gross lesions of gastric tuberculosis or a good description of the gross lesions and a poor description of the histopathological lesions. He found 49 positive and 119 probable cases. Good,[6] in 1931, added 2 positive and 24 probable cases. Up to the end of 1937 54 positive and 157 probable cases had been reported as reviewed by Chaffin.[3] Clagett and Walters,[4] in 1938 stated that only 368 cases had been reported in the literature. This apparently included positive, probable and possible cases. Four cases were added by Sullivan, Francona and Kirshbaum[10] and by Connolly,[5] making a total of 373 acceptable cases prior to 1942, as reviewed by Browne, McHardy and Wilen.[2] Since then, Hartz and van der Sar[7] and White[12] have each added one case.

That the condition is rare may be seen by a glance at Table 1.

TABLE I

Author	No. Tuberculosis Autopsies	Cases of Gastric Tuberculosis	Per Cent
Good	15,165	80	.52
Sullivan, *et al.*	554	2	.35
Glaubitt	2,237	47	2.00
Simmonds	2,360	18	.76
Browne, *et al.*	1,321	30	.22
Hartz and van der Sar	1,102	1	.10

To further emphasize the rarity of gastric tuberculosis, there have been only 10 cases at the Mayo Clinic,[12] up to the present. In 75,000 surgical specimens examined at the Cook County Hospital[10] only one case of gastric tuberculosis was found.

Tuberculosis of the stomach is rare, probably because of (1) the rapid expulsion of the bacilli from the stomach by peristalsis and (2) the relative scarcity of lymphatics. Most cases of gastric tuberculosis are confined to the prepyloric area where the lymphatic supply is the most abundant. It should be considered in the differential diagnosis of prepyloric filling defects along with peptic ulcer, neoplasm and syphilis. There are no distinguishing roentgen characteristics and the condition is generally diagnosed as one of the above. This is of practical significance inasmuch as patients practically never recover from resection of a tuberculous stomach.

Broders classified the condition into (1) miliary tubercles of the stomach; (2) solitary tubercle; (3) tuberculous ulcer, and (4) pyloric stenosing tuberculosis. The case herein reported had features of all the pathological changes except the solitary tubercle. There were miliary tubercles, ulcers and stenosis.

The prerequisites of a positive case are fulfilled since the pathological alterations are typical and tubercle bacilli were demonstrated.

CASE REPORT

A colored male, aged twenty-three, entered the hospital on March 20, 1944, complaining of constant aching pain in the lower mid-abdomen and less severe pain in the epigastrium, associated with bloating of the stomach and sour eructations for the past four months. During this time, he had vomited at least once daily

after taking food or fluid and had lost 23 pounds. His appetite remained normal.

The patient had measles and pertussis in childhood, pyogenic osteomyelitis of the distal left femur at the age of thirteen, pneumonia in 1939 and a broken rib in 1942.

Tobacco and alcohol were used in moderation. The family history was non-contributory.

In the physical examination, the only positive finding was slight tenderness in the epigastrium and lower abdomen on deep palpation.

The laboratory findings were as follows: Red blood cell count 4,830,000; hemoglobin 85 per cent; red blood cell morphology normal; white blood cell count 4,800, with 59 per cent neutrophiles, 41 per cent lymphocytes. Kahn reaction negative. Total serum protein 7.6 gm. per 100 cc., albumin 4.6 gm. per 100 cc., globulin 2 gm. per 100 cc. Spinal fluid: white blood cells 8 per cubic millimeter and many red blood cells; cloudy. Total protein 25 mg. per 100 cc. Wassermann and gold curve negative. Urine: normal. Feces: three plus occult blood on several occasions.

The clinical impression was obstructing prepyloric or duodenal ulcer. The roentgen examination of the stomach showed marked narrowing in the prepyloric region of the stomach with marked dilatation and retention of fluid. Very little opaque material could be expressed into the duodenum. A twenty-four hour roentgenogram showed retention of nearly all the contrast medium. The roentgen diagnosis was obstructing prepyloric ulcer.

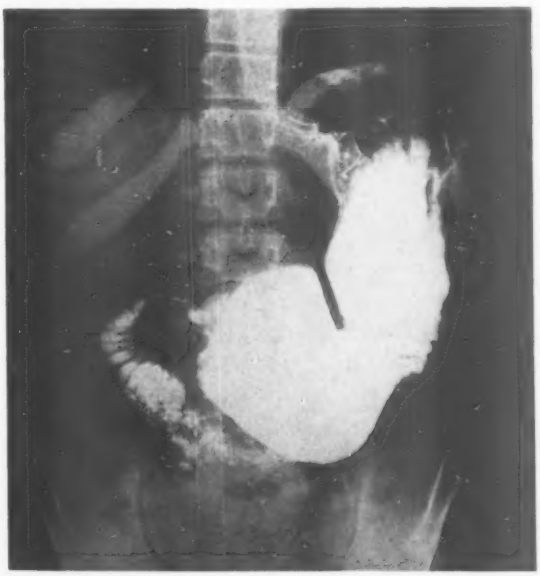

Fig. 1. Roentgenogram showing the dilated stomach and marked prepyloric narrowing with partial obstruction.

Fig. 2. Roentgenogram one month later. This film was taken twenty-four hours after the oral ingestion of barium. The obstruction is now practically complete.

A laparotomy was performed on April 10, 1944. The stomach was found to be tremendously dilated. At the pre-pyloric end of the stomach, there was a large irregular mass. The anterior surface of the first portion of the duodenum and of the pylorus was scarred and irregular. Multiple edematous lymph glands were encountered in the omentum along the greater curvature. A frozen section of one of these showed typical tubercles. The involved portions of the stomach and duodenum were resected and a jejunogastric anastomosis performed.

The postoperative course was stormy. The patient developed recurrent hiccoughs, shortness of breath, cough, and elevation of the diaphragm. Increased density in the right base was demonstrated on portable roentgen examination. Later oliguria, abdominal distention and jaundice developed. The pulse rate gradually rose to 120 per minute, respirations to 32 and the patient died on April 19, 1944, of respiratory embarrassment and acute diffuse peritonitis.

The resected portion of the stomach and duodenum showed marked pyloric obstruction, several recent pyloric and duodenal erosions and great thickening of the wall and submucosa of the stomach; many yellowish-white gelatinous

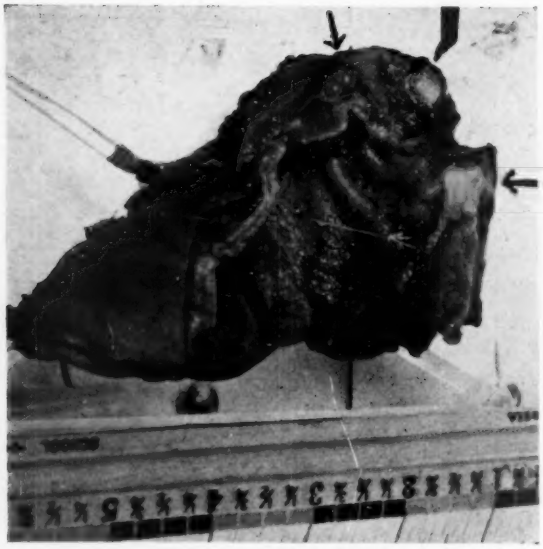

FIG. 3. The resected specimen showing a thickened nodular wall, conglomerate tubercles undergoing caseation necrosis, and roughening of the serosal coat.

areas showing caseation were present in the pylorus. Several of the peripyloric lymph nodes showed extensive involvement with caseation. The histopathological picture of the lesions in the stomach and omental lymph nodes was that of tuberculosis. Characteristic acid-fast bacilli were found in the tissues. Animals inoculated with parts of the lymph nodes did not develop tuberculosis. There were many foci of acute inflammatory reaction in areas where tubercles were present and the acute erosions and ulcers of the mucosa seemed related to the foci of tuberculosis, probably caused by breaking down of tissues and secondary infection from the surface.

The pathological diagnosis was tuberculosis of the omental lymph nodes, tuberculosis of the stomach and duodenum, pyloric obstruction, acute ulcers of the stomach and duodenum.

A thorough autopsy failed to reveal any pulmonary or other tuberculous focus although there probably was one. Primary tuberculosis of the stomach has never been reported.

SUMMARY AND CONCLUSION

A case of gastric tuberculosis is reported. A short review of the literature and discussion of the condition are presented.

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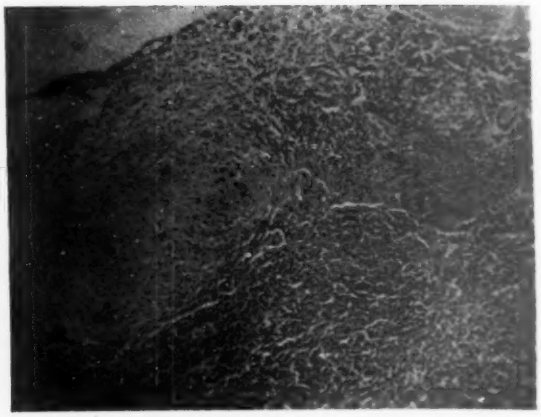

FIG. 4. Photomicrograph showing coalescence of two tubercles. There is a dense lymphocytic infiltrate and numerous giant cells.

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VOL. 59, NO. 5

TUMORS OF THE SMALL INTESTINE

REPORT OF TWO CASES OF CARCINOMA OF THE JEJUNUM

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TUMORS of the small intestine are infrequent in the experience of most physicians. A good index of the rarity of carcinoma of the small intestine is to be found in a paper from the Mayo Clinic.[13] In this it was pointed out that during a period (1921–1930) in which 25 cases of carcinoma of the small intestine were observed, 2,767 cases of carcinoma of the large intestine, and 2,513 cases of carcinoma of the stomach were seen at the Clinic. Raiford at Johns Hopkins Hospital found 88 cases of tumor of the small intestine in 11,500 autopsies;[3] Johnson found only 2 cases of carcinoma of the small intestine in 20,000 autopsies on adults; Bunting reported only 1 in 2,200 autopsies.

In striving for what might be called a working concept of tumors of the small intestine, a study of numerous tables and statistical summaries arranges the salient facts pertaining to these tumors somewhat in the following manner:

1. The majority of tumors of the small intestine are malignant.

2. A great variety of tumors of the small intestine has been described, including lipoma, fibroma, carcinoid, leiomyoma, pancreatic rests, chorionepithelioma, angioma, adenoma, neuroblastoma, but reports of most of these are infrequent and sporadic.

3. As to the total number of cases of tumors of the small intestine in the literature, while there is some variation in the reports, the number seems to be between 300 and 400.

4. The predominant malignant lesions are adenocarcinoma and lymphosarcoma.

5. Adenocarcinoma is more frequent in the jejunum; lymphosarcoma in the ileum.

6. The cardinal symptoms include the following:

a. Recurrent episodes of intestinal obstruction, tending to become more severe.

b. Anemia of the microcytic, hypochromic type; the anemia is comparable to that found in lesions of the right half of the colon.

c. Malignant lesions of the small intestine occur three times as frequently in males as in females; most frequent age, forty to fifty.

d. Malignant lesions of the small intestine are not infrequently responsible for intestinal hemorrhage; they may also cause intussusception and, rarely, perforation.

REPORT OF CASES

CASE 1. This patient was a white female, aged sixty-three, who had for some time com-

FIG. 1. Case 1. The narrowing at the ligament of Treitz has caused partial obstruction with some dilatation of the duodenum.

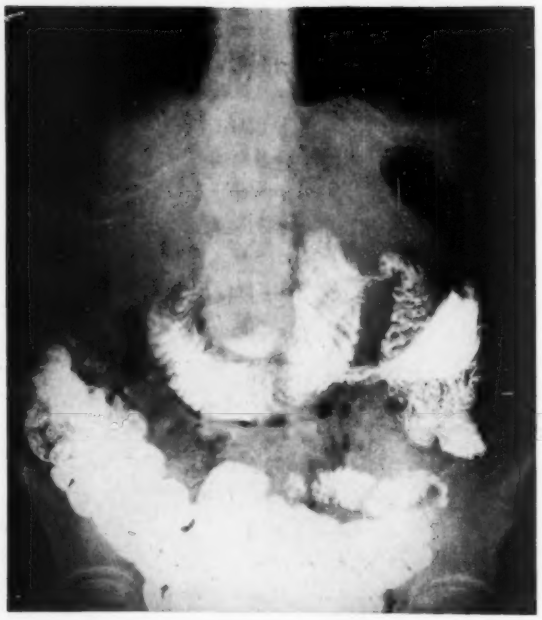

FIG. 2. Case I. At five hours the stomach is nearly empty. The narrow lumen at the duodenojejunal junction is again visible and the duodenum is dilated.

plained of vomiting. This rarely occurred until evening when she would vomit all she had eaten that day. The vomiting became more severe and she entered the hospital for observation.

Examination of the upper gastrointestinal tract revealed a narrowing of the intestine at the ligament of Treitz. Since this is a frequent site of mesenteric anomalies and since the mucosa of the narrowed intestine did not seem too greatly altered, I was inclined to believe that an extrinsic factor was responsible for the obstruction.

At operation a tumor of the intestine was found and resected. The report of the pathologist, Dr. John Kiselis, was as follows: "Section of tumor reveals the surface in areas to be lined by mucosa containing normal glands. Stroma is markedly infiltrated with round cells and plasma cells. In some areas the surface consists of large, irregularly shaped glands, lined by irregular columnar epithelium. Nuclei are large and vesicular. Entire wall is infiltrated by large and small irregular glands, lined by tall columnar epithelium. In areas beneath the normal mucosa tumor glands can be seen. Adenocarcinoma of jejunum."

CASE II. The second patient was a white female, aged eighty-two, with a history of vomiting for five days. Roentgenoscopy made apparent a wide dilatation of the upper jejunal loops, with an area of narrowing about 6 feet from the ligament of Treitz.

At operation, a tumor was resected, and the report of the pathologist, Dr. John Kiselis, is as follows: "Specimen consists of a tumor of the jejunum. Section reveals the surface for the most part to be covered with a thick layer of fibrin and degenerated leukocytes. Just beneath this there can be seen many pools of red blood cells. Underlying stroma consists of a loose fibroblastic structure with many capillaries. In this stroma there can be seen many small and large groups of closely packed cells irregular in shape, with lightly staining nuclei. Occasional nucleus is hyperchromatic. The nuclei are prominent, and the cytoplasm for the most part abundant. Scattered throughout the stroma there are isolated tumor cells. Many mitotic figures are seen. In a few areas the cells have a tendency toward glandular formation. Adenocarcinoma of jejunum."

FIG. 3. Case II. Roentgenogram shows distal jejunal lesion with dilatation characteristic of intestinal obstruction. Immediate operation revealed a tumor.

As an example of the wide discrepancy between the experience of any one individual, and the experience of the medical

profession as a whole, it seems worthy of mention that these two malignant tumors of the jejunum came to a four hundred bed hospital within the same month, and both on the service of the same attending physician, Dr. Walter Lawrence.

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A SIMPLIFIED METHOD OF ROENTGEN PELVICEPHALOMETRY

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WHEREAS accurate roentgen measurements of the maternal pelvis have been routine for many years, similar accuracy has not been possible for those of the fetal skull without more or less elaborate apparatus and calculations. Cephalometry has been especially difficult when the head is not engaged, either in vertex or breech presentation. For the past four years the author has been investigating a method which yields accurate cephalic measurements in both vertex and breech presentations and which, though evolved from a relatively small number of cases, appears worthy of publication for further study by those having a larger source of clinical material. The principle employed has been referred to, though with different application, by Walton[4] and Snow;[3] a reasonably careful survey has failed to reveal any other references to a similar method and so far as is known, this is an independent and original procedure.

Having observed that in a majority of cases the fetal skull lies nearly in the maternal midline and in a reasonably sagittal or lateral plane in the film used for the anteroposterior view of the abdomen, it became evident that if the height of the skull above that film could be determined, it should be relatively simple to correct for distortion due to magnification and thus calculate the desired skull dimensions. To accomplish this purpose a view at right angles to that used for the anteroposterior view is made with the patient still recumbent (Fig. 3). Knowing the target-film distance and the distance from the midline of the patient to the film, it is possible to calculate not only the height of the fetal skull above the anteroposterior view but also the heights of maternal pelvic planes and, in most instances, one or more of the fetal skull diameters.

Advantages of the method are that it is technically simple, requiring only standard roentgenologic projections; that the only measurements required in the roentgenographic room are from the midline of the patient to fixed surfaces, and so, well within the ability of any reasonably well trained technician; and that the calculations can be made rapidly and on wet films if need be.

The series of cases upon which this report is based comprises upward of 200 examinations drawn almost entirely from private practice, with close follow-up in 146 cases. It has not been possible to achieve complete correlation in all cases since many were home deliveries and some were in hospitals to whose records access could not be obtained.

It has been found that examination is more reliable if done within the last two weeks of gestation since the fetal skull shows little increase during that period.

METHOD

In the case of vertex presentation four films are made; when there is a breech presentation it is usually necessary to make one or two additional views centered over the fetal skull.

Film 1 (Fig. 1). This is a semi-erect view similar to that described by Walton[4] and is made with the patient sitting at an angle of about 45°–55° from the horizontal, supported by her arms outstretched behind. The back-rest has been discarded because it is cumbersome and time consuming and patients have no difficulty remaining immobile for a sufficient length of time to permit exposure of the film. The tube and film are centered opposite the anterior superior iliac spine, with the patient in the midline of the table. A 10 by 12 inch film is adequate. Exposure factors are in the

range of 300–500 ma-sec., 65–75 kv. (peak), 40 inch target-film distance.

Since no measurements are made from this roentgenogram it is not necessary to measure the height of the symphysis pubis from the table top. It was found, in a small series of cases, that this measurement was inaccurate often to as much as 5.5 cm., level. No pad is used under the lumbar region since it was found that in tilting the pelvis to show its contour, the fetal head was rotated from a true projection in many cases. Factors used are 150–250 ma-sec., 65–75 kv. (peak), 40 inch target-film distance. It is advisable to have the patient take three or four deep breaths before

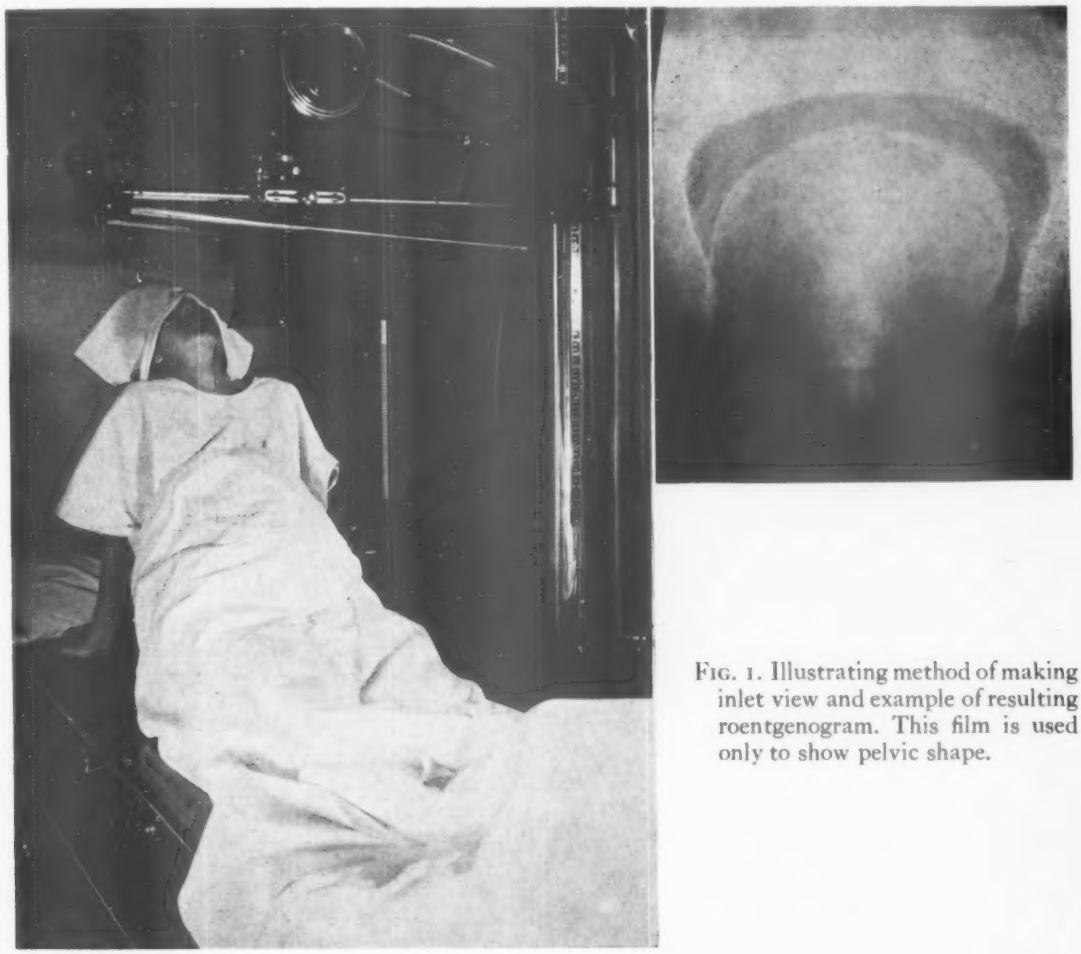

FIG. 1. Illustrating method of making inlet view and example of resulting roentgenogram. This film is used only to show pelvic shape.

and further that the procedure was distasteful to many patients. This view is used only to determine pelvic shape.

Film 2 (Fig. 2) is the standard anteroposterior view made on a 14 by 17 inch film to include the maternal pelvis and as much as possible of the abdomen. If the presentation is breech and the entire fetal skull not included on this film, a 10 by 12 inch view is made centered over the skull at the higher making the exposure in order to provide the fetus with sufficient oxygen to minimize motion.

Film 3 (Fig. 3). This roentgenogram is used to determine the heights of the fetal skull and pelvic planes above the preceding anteroposterior view and is made immediately following it in order that there be no disturbance of relative positions. The patient is slid to the side of the table away

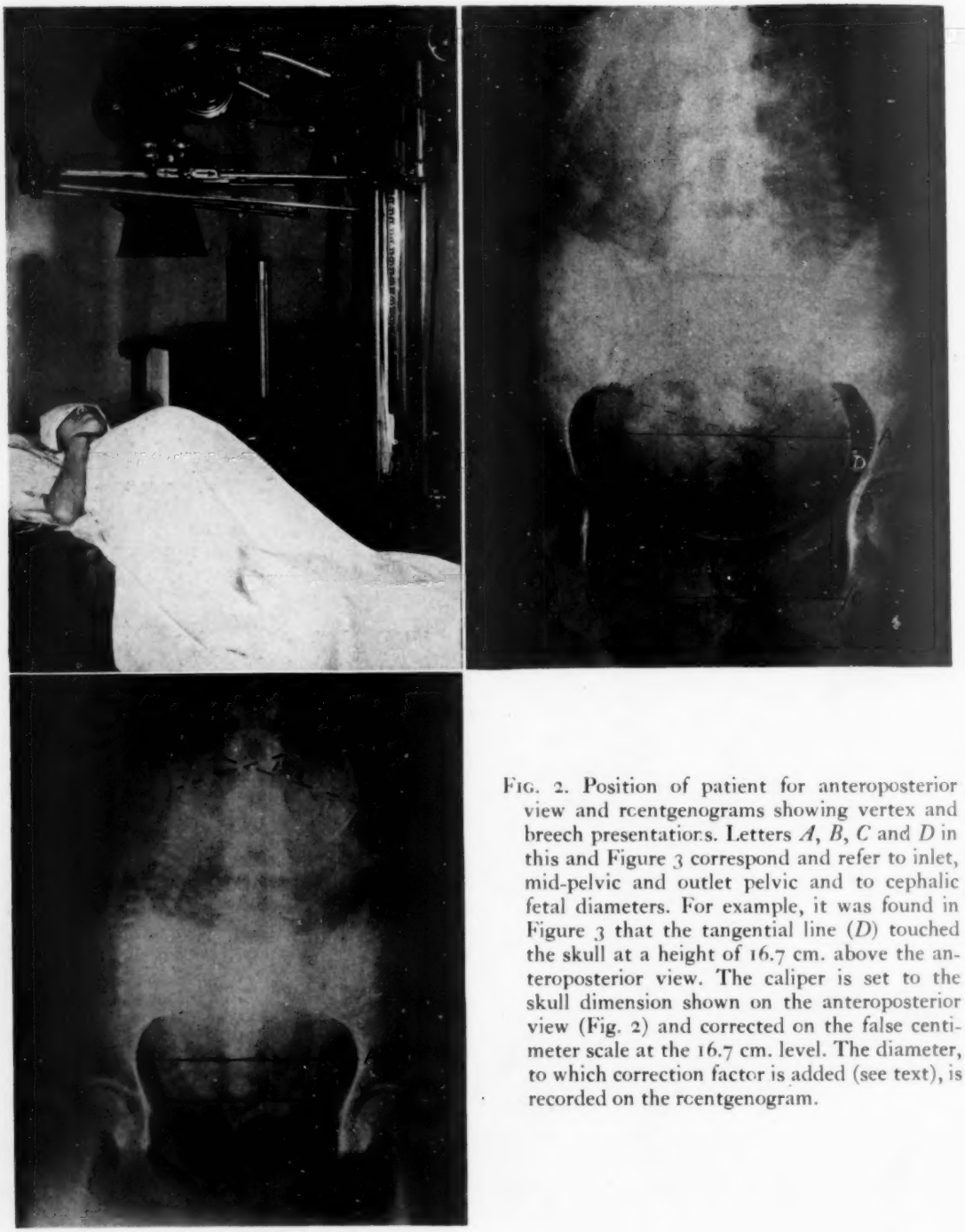

FIG. 2. Position of patient for anteroposterior view and roentgenograms showing vertex and breech presentations. Letters *A*, *B*, *C* and *D* in this and Figure 3 correspond and refer to inlet, mid-pelvic and outlet pelvic and to cephalic fetal diameters. For example, it was found in Figure 3 that the tangential line (*D*) touched the skull at a height of 16.7 cm. above the anteroposterior view. The caliper is set to the skull dimension shown on the anteroposterior view (Fig. 2) and corrected on the false centimeter scale at the 16.7 cm. level. The diameter, to which correction factor is added (see text), is recorded on the roentgenogram.

from the roentgen tube, with the margin of her hip even with the edge of the table. A 10 by 12 or 11 by 14 inch film is placed vertically with its center opposite a line midway between the symphysis and the anterior superior spine of the ilium; a wafer grid is interposed between the patient and the cassette. The cassette and grid are rested on the partially withdrawn Bucky tray and are maintained in position by sand bags. The roentgen tube is turned horizontally and is centered to the film. It is desir-

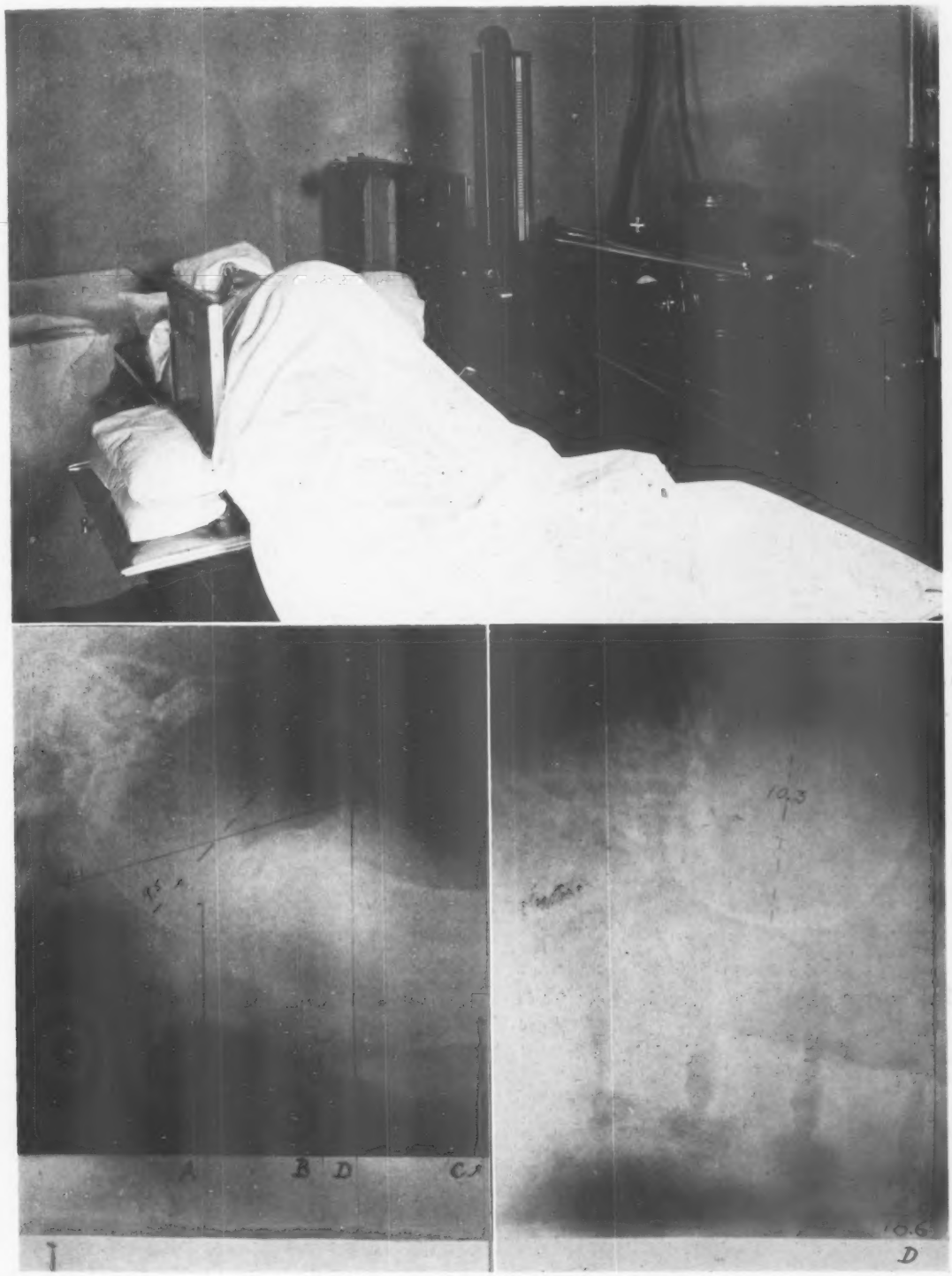

FIG. 3. Placement of patient, film and tube for transverse horizontal view and roentgenograms of vertex and breech presentations. Measurements are made from landmark points to the upper margin of the clear zone, which represents the shadow of the table top, and 4.0 cm. added. Calculation is made on the false centimeter scale at the level corresponding to the distance from the midline of the patient to the film, thus determining the height of the inlet, mid-pelvic and outlet pelvic planes and of the fetal skull above the anteroposterior view (Fig. 2).

able to have the central ray parallel to and at a height of about 8 cm. above the table top; with some equipment it is not possible to depress the tube to that extent and we have found that downward angulation to 5° does not interfere with accuracy. Technical factors vary from 400–600 ma-sec., 65–75 kv. (peak). The distance from the target to the film for our apparatus is 40 inches, and it is this distance which determines that to be used for other views; hence it is recommended that careful measurement be made for individual apparatus, and technique standardized in accordance. In case of breech presentation it is necessary to make an additional view at higher level opposite the fetal skull; somewhat less penetration or shorter time is required in this event. The distance from the midline of the patient to the surface of the wafer grid is measured by the technician and 1.0 cm. added since that has been found to be the distance from the surface of the grid to the film within the cassette. This figure is then recorded and may be inscribed on the wet film.

In the finished roentgenogram a clear zone is seen along the lower edge; the margin between this zone and the exposed portion represents the level of the table top.

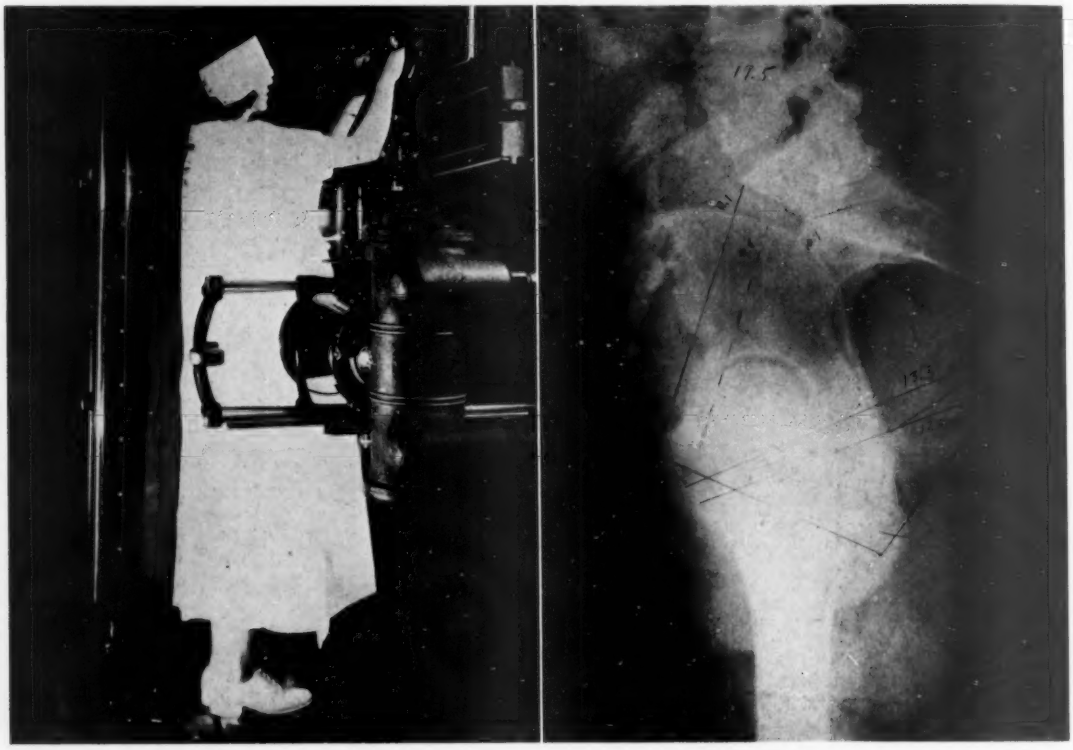

FIG. 4. Erect lateral view showing positioning of patient and finished roentgenogram. Calculation of diameters is made on the line of the false centimeter scale corresponding to the distance from the midline of the patient to the film in the Bucky tray.

Film 4 (Fig. 4). The lateral view is made with the patient erect since it has been found that the head descends to an appreciably lower level than when she is in lateral recumbent position. With rare exceptions it is possible to do this even in the presence of active labor. A 14 by 17 inch film, lengthwise, is used and it is important that this be a true lateral with the femoral heads

superimposed. If the patient's left side has been toward the tube for the transverse view (film 3), her right is toward the tube for the erect lateral in order to avoid any possibility of overexposure. In this connection it may be mentioned that in a few cases we have had to repeat one or both of the lateral views at the time of initial examination and in a few the entire procedure has been repeated within two weeks. There has never been any evidence of skin reaction and we are therefore convinced that exposures are well within tolerance.

The film and tube are centered, as for the transverse view, to a line midway between the symphysis pubis and the anterior superior spine of the ilium.

The distance from the patient's midline to the table top is measured and to it 4.0 cm. added, this having been found to be the distance from the surface of the table to the film within the cassette in the Bucky tray. This measurement is recorded and may be inscribed on the wet film. Factors used are 300–600 ma-sec., 75–85 kv. (peak), 40 inch target-film distance.

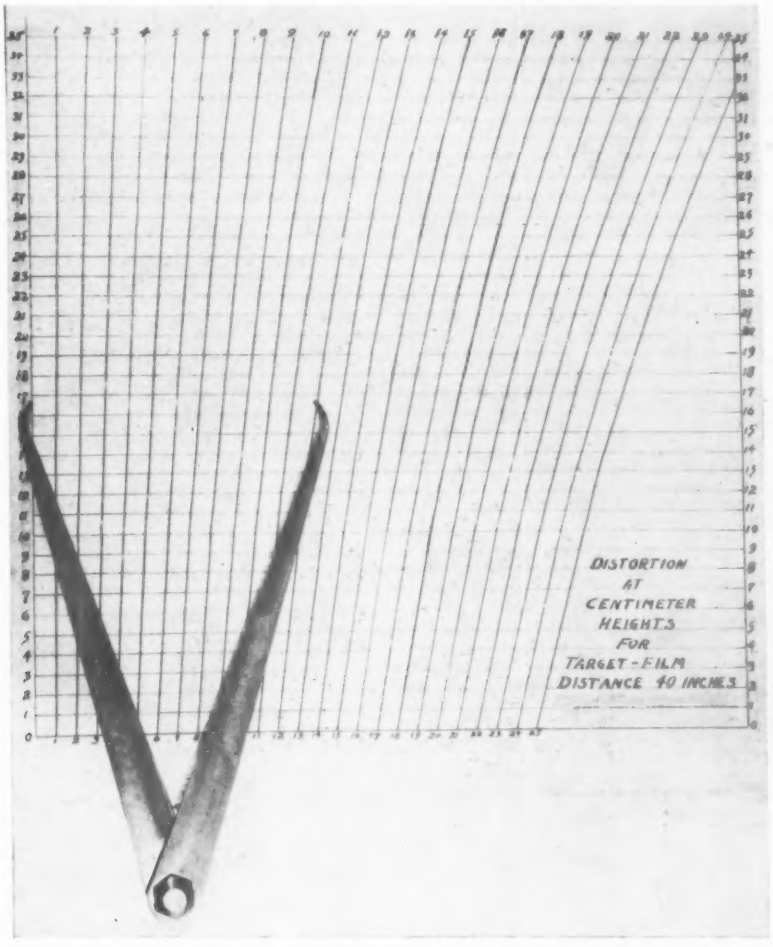

FIG. 5. False centimeter scale for target-film distance of 40 inches. Calipers are shown spread to fronto-occipital diameter in original film used for Figure 2 and correction made at 16.7 cm. level of the scale, since such was the height of the skull above that film as found in Figure 3. A similar method is used to find the height of pelvic planes above the anteroposterior view.

CALCULATIONS

A false centimeter scale (Fig. 5)* has been constructed for the 40 inch target-film distance similar to that developed by Walton for a 30 inch distance. It is comparatively simple to make, and hastens calculations. It is possible, though more tedious, to use the mathematical formula[3]

$$\frac{\text{Tube to film distance}}{\text{(Tube to film distance)} - \text{(Object to film distance)}} = \frac{\text{roentgen image diameter}}{\text{original diameter}}$$

Other methods such as perforated or notched lead strips or lead shot at centimeter intervals at the patient's midline, or the elastic ruler developed by Gianturco[2] may be used. It is entirely possible that development of suitable apparatus designed to operate at 6 foot target-film distance may obviate necessity for such aids and permit measurements in centimeters directly on the roentgenograms.

Film 1. As noted above, the inlet view is used only to ascertain the pelvic shape. It is possible, when the head is engaged, to form a good idea from it as to the relative proportion of the skull to the pelvic inlet but not to the mid-pelvic and outlet planes; and if the head is not engaged no reliable determination of relationship can be made.

Measurements are made, in respective order, on films 3, 2 and 4.

Film 3 (Fig. 3). In a roentgenogram of good quality it is possible to identify the four necessary points: (*a*) a curved line extending from the symphysis pubis to the promontory of the sacrum and representing the margins of the pelvic inlet; the widest point of the inlet is usually about 1 inch cephalad to the upper margin of the femoral head and a perpendicular is dropped from this point to the margin of the clear zone along the lower border of the film; (*b*) the ischial spines are identified and a perpendicular dropped. In the event that the spines are not superimposed, a point midway between their tips is taken as the starting point for the perpendicular; (*c*) the ischial tuberosities are identified and a perpendicular is dropped; the level of the tuberosities will usually be found nearly that of the spines, but in a roentgenogram of good quality it is possible to identify the lower margins of the ischia and to place the level of the tuberosities about 1 cm. higher. In case the tuberosities are not superimposed, the starting point of the perpendicular is placed midway between them. Recently it has been found helpful to flex the thighs to about 30° and thus show the ischia more clearly; (*d*) a perpendicular is drawn tangential to the fetal skull.

From these perpendiculars it is possible to determine by suitable method for correction of distortion, the respective heights of the inlet, mid-pelvic and outlet planes of the maternal pelvis and the fetal cephalic above the table top. If a false centimeter scale is used the correction is made on the line of the scale corresponding to the mid-patient to film distance; this distance is also used when calculations are to be made by mathematical formula. To the corrected distances found it is then necessary to add the distance from the table top to the film within the Bucky tray used for the antero-posterior view (film 2); this can be found by simple means[1] and in the case of our apparatus is 4.0 cm. The corrected measurements with 4.0 cm. added are inscribed on the film and are used in calculating diameters on film 2.

In this roentgenogram is it usually possible to visualize the fetal skull in sagittal projection; occasionally it is seen in lateral. Using the correction for distortion it is possible to determine the diameter in centimeters.

It occasionally happens that the head, in

* Our scales were drawn on paper then photographed actual size and printed on translucent film material, then mounted between sheets of plastic. It has been found that if the completed chart is subjected to heat, such as from a viewbox, some shrinkage of the scale is likely to take place due to contraction of the film. It is preferable to have them made on paper or film having low shrinkage and not expose them to heat.

a breech presentation, does not lie in the midline. In this event the distance from the patient's midline to the midpoint of the skull is measured on film 2; if the head is closer to the film (film 3) than the patient's midline, the distance found is subtracted from the midline to film distance, and the resulting figure used as the line on the false centimeter scale (or in mathematical computation as the object-film distance). Similarly, if the head is farther from film 3 than the mother's midline, the difference is added to the midline to film distance. For example, if the head is 6.0 cm. closer to the film than a measured mid-patient to film distance of 23.0 cm., the object to film distance is 17 cm., and correction is made on that line of the false centimeter scale. While this procedure is open to criticism on the grounds that it does not take into account distortion of the 6.0 cm., in practice it has proved to be reliable and there appears to be no good reason for complicating the calculation.

Film 2 (Fig. 2). Transverse lines are drawn at (*A*) the widest point of the inlet, (*B*) between the ischial spines and (*C*) between the slightly curved radiolucent lines representing the inner margins of the ischial tuberosities and they represent respectively the transverse diameters of the inlet, mid-pelvis and outlet. Broken lines (*D*) are drawn along the greatest diameters of the skull—generally the fronto-occipital and suboccipitobregmatic diameters are seen, occasionally the biparietal.

Correction for distortion is made on the level of the false centimeter scale corresponding to the height of each part (found in film 3) above the anteroposterior view (film 2). Thus if, for example, the height of the most prominent part of the skull be found 16.7 cm. (Fig. 3), correction is made at this level on the false centimeter scale (Fig. 5). Similarly for the transverse pelvic planes. If mathematic computation be employed, these distances are used as the "object-film distance" in the formula.

Film 4 (Fig. 4). On this roentgenogram the standard anteroposterior measurements in sagittal plane are made, viz. true conjugate, anteroposterior and posterior sagittal of mid-pelvis, and anteroposterior, pubotuberous and posterior sagittal of the outlet. In general, the fetal skull is seen in biparietal plane but occasionally it is lateral. Pelvic diameters are delineated by solid lines, those of the fetal skull by broken lines.

Correction for distortion is made as described above, using the patient midline to film distance on the false centimeter scale or in the mathematical formula. Thus, if the patient's midline is 22.0 cm. from the film, the corresponding line on the false centimeter scale is used for correction and similarly in the formula. *It is important that the distance be from the midline of the patient to the film*, not from midline of the patient to the table top. The measurements as corrected are recorded on the roentgenogram.

Maternal Measurements		Fetal Measurements
Inlet	True conjugate	Fronto-occipital
	Transverse	Biparietal
		Suboccipitobregmatic
Mid-Pelvis	Anteroposterior	
	Posterior sagittal	Pelvic shape
	Transverse	Sacral curve
		Stage of gestation
Outlet	Anteroposterior	Presentation
	Pubotuberous	Placenta implantation
	Posterior sagittal	
	Transverse	
Conclusion:		

Fig. 6. Specimen of report form.

CORRELATION OF RESULTS

Correction for Fetal Skull Diameters (Table 1). It has been possible to compare the measurements made by cephalometry using the above method, with actual postpartum determinations in 61 cases. When delivery was by cesarean section, the postpartum measurement was made within a few hours of birth; when there was considerable moulding following vaginal delivery, a longer period of time was allowed to elapse in order to partially correct the distortion. Tabulation of results is shown for the various types of presentation and delivery. It will be noted that for the entire series the fronto-occipital diameter averaged 0.7 cm. less and the biparietal diameter 0.5 cm. less by calculation than was actually found postpartum; these figures have been accepted as representing the thickness of soft tissues of the scalp; hence to these diameters as found by cephalometry, we add 0.7 and 0.5 cm. respectively as correction factors. The correction factor for suboccipitobregmatic diameter has been found, in the few cases measured, to be the same as for the fronto-occipital.

TABLE I

AGREEMENT BETWEEN ESTIMATED AND POSTPARTUM MEASUREMENTS—61 CASES

Average measurements for respective series

A. ENTIRE SERIES

	Fronto-occipital		Biparietal	
	Estimated	Postpartum	Estimated	Postpartum
	11.5 cm.	12.2 cm.	9.2 cm.	9.7 cm.
Correction factor	plus 0.7 cm.		plus 0.5 cm.	

B. CESAREAN SECTIONS, VERTEX PRESENTATION—7 cases

	Fronto-occipital		Biparietal	
	Estimated	Postpartum	Estimated	Postpartum
	11.9 cm.	12.7 cm.	10.1 cm.	10.3 cm.
Correction factor	plus 0.8 cm.		plus 0.2 cm.	

C. CESAREAN SECTION, BREECH PRESENTATION—5 cases

	Fronto-occipital		Biparietal	
	Estimated	Postpartum	Estimated	Postpartum
	11.9 cm.	12.1 cm.	9.7 cm.	9.6 cm.
Correction factor	plus 0.2 cm.		minus 0.1 cm.	

D. ALL BREECH CASES—7 cases

	Fronto-occipital		Biparietal	
	Estimated	Postpartum	Estimated	Postpartum
	11.9 cm.	12.3 cm.	9.8 cm.	9.9 cm.
Correction factor	plus 0.4 cm.		plus 0.1 cm.	

E. ALL CESAREAN SECTIONS—12 cases

	Fronto-occipital		Biparietal	
	Estimated	Postpartum	Estimated	Postpartum
	11.9 cm.	12.3 cm.	9.9 cm.	10.1 cm.
Correction factor	plus 0.4 cm.		plus 0.2 cm.	

There have been some inaccuracies; in 2 or 3 cases they amounted to as much as 1.5 cm. for the fronto-occipital diameter. It has been found that these have been due to rotation of the skull from a true projection, and though they have been infrequent, when encountered the fact is noted on the report to the referrring physician and allowance made by addition of 1.0 cm. to the fronto-occipital and 0.7 cm. to the biparietal estimated diameters. It has been gratifying to find absolute agreement between anticipated and actual postpartum

measurements in an increasing number of cases after more mature experience.*

Comparison between Predicted and Actual Progress (Table II). It was possible to obtain records permitting evaluation of predicted and actual courses in 85 cases. It should be emphasized that cephalic-pelvic proportion was not the only criterion. Such factors as pelvic shape, form of sacrum, age and parity of patient, presentation, history of preceding labors, and so forth, were taken into account. Measurements have been of special value in determining presence or absence of disproportion between the head and the mid-pelvic diameters and in 2 or 3 cases where a recommendation of cesarean section for such disparity was not accepted and trial of labor attempted, surgical intervention had to be resorted to in order to effect delivery.

Cesarean section has been recommended, generally, when there was evidence of absolute disproportion, when the pelvic shape or sacral form appeared to be unfavorable or where the patient's age or other factors indicated. In some cases, trial of labor has been advised with preparation for section if progress was not satisfactory; such borderline recommendations have been less frequent with increased experience.

TABLE II

COMPARISON BETWEEN PREDICTED COURSE AND OUTCOME WITH ACTUAL PROGRESS—85 CASES

A. Vaginal delivery recommended 62 cases
Vaginal delivery effected 61 cases*
No difficulty experienced 50 cases
Low forceps 5 cases
Mid forceps 4 cases
High forceps 2 cases**

* 1 cesarean section on clinical grounds; Rh negative mother, Rh positive father, 57 hour, high forceps labor 7 years previously.

** 1 stillbirth—prolonged labor, high forceps extraction, shoulders impacted. Roentgenographically no disproportion. Dystocia considered due to edema of maternal pelvic soft tissues.

B. Cesarean section recommended 19 cases
Cesarean section performed 18 cases

1 case brow presentation persistent for several hours. Patient prepared for section after long labor; presentation converted to vertex spontaneously just before section commenced and spontaneous delivery without difficulty resulted.

C. Cesarean section preferable 4 cases

Chief reason for preference		Outcome
Flat sacrum	1 case	Vaginal delivery: no difficulty
Narrow mid-pelvis	1 case	Vaginal delivery: low forceps
Close measurements, pre-eclamptic tendency	1 case	Vaginal delivery: no difficulty
Flat sacrum, 31 year old primipara	1 case	Manual rotation: high forceps: laceration of cervix

D. Breech presentations 9 cases (1 twin)
Vaginal delivery recommended and accomplished without difficulty 5 cases
Cesarean delivery recommended and accomplished 4 cases

E. Summary—Reliability of recommended vs. actual procedure 85 cases
1 stillbirth
1 section recommended but not required
4 section preferable but delivered per vaginam
—
6 cases Accuracy 93 per cent

* Since this paper was submitted for publication a case having twin vertex presentations was measured; postpartum measurement of skull diameters by the attending obstetrician showed actual diameters for each skull within 3–5 mm. of those predicted.

In 6 cases there was disagreement between predicted and clinical course. In 4 of these (Table IIC) it is felt that the error was on the side of safety, but they have been charged as unreliable predictions. The section performed (Table IIA) for clinical reasons has not been charged as unreliable. It is debatable whether the high forceps delivery (Table IIC) might not have benefited more from a section.

In addition, inquiry has been made of referring physicians as to the value of the method, in which regard it is gratifying to find repeat referrals becoming more frequent. It has also been noted that as confidence has increased there is a tendency on the part of obstetricians to accept the recommendation made. Close cooperation between obstetrician and roentgenologist has been a source of great satisfaction and has undoubtedly played a highly important part in reliability of predictions and advice.

SUMMARY

A method of pelvicephalometry having the advantage of technical simplicity with ease of calculation and evaluation of results has been presented. It is hoped that it will be investigated further by those having larger sources of clinical material.

Material for this investigation has originated in De Paul Hospital, Norfolk, Va., Holy Cross and St. Mark's Hospitals, and from the author's private practice in association with James P. Kerby, M.D., Salt Lake City. Upward of fifteen different obstetricians have referred patients from time to time; designation of all by name is impossible and the author's indebtedness is therefore acknowledged to all who have been interested in this investigation.

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Vol. 59, No. 5

SOLITARY UNICAMERAL BONE CYST OF RIGHT ILIUM*

A CASE REPORT

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SOLITARY unicameral bone cyst is now regarded as a distinctive lesion, which should be differentiated from the other forms of fibrocystic disease of bone. The condition, though relatively rare, is often encountered in childhood and adolescence. The lesion develops in the long bones with greatest frequency, particularly in the proximal third of the humerus and femur and to a lesser degree in the tibia. Occasionally other bones may be involved. Review of the accessible literature indicates that only a small fraction of the total cases are found in skeletal structures other than the long pipe bones.

As is often the case, a cyst may attain sizeable proportions before its presence is discovered. Many times it is unrecognized until slight trauma produces pathological fracture of the cyst wall, following which medical aid is sought. It is often possible to elicit a history of localized or radiating pain characterized by exacerbations and remissions, and aggravated by exercise or manual labor. These cysts may remain asymptomatic for two or three years or even longer. Although our patient gave a history of localized pain of two years' duration, others with symptoms of twenty years' duration have been described.

Recently Jaffe and Lichtenstein reported 19 cases of unicameral bone cyst. All lesions in their series involved the long bones. Of the entire group 15 were between the ages of three and fourteen, the remaining 4 cases being sixteen, eighteen, twenty and forty-two years of age, respectively. It is noteworthy that not a single case of unicameral cyst of a flat bone is reported in this series. However, Lichtenstein[21] in a personal communication states that more recently he has encountered one case in a woman, aged forty-six, who complained of hip pain and right lower backache for one week. The cyst was located in the posterior part of the right iliac bone and contained blood-tinged fluid. Its outer wall was only a thin osseous shell. The patient was completely relieved by operation.

A case presenting a problem in differential diagnosis and recently operated upon in the Percy Jones General Hospital was found to be a solitary unicameral cyst of the right ilium (Fig. 1). The rarity of a cystic lesion of this nature in a flat bone warrants a detailed presentation.

CASE REPORT

A white soldier, aged twenty-three, reported to sick call in Luzon, because of recent discomfort in his right hip and the sacroiliac region. The pain radiated down the right thigh to the knee. Symptoms of a mild degree had been present for approximately two years. The pain had gradually increased since onset and was characterized by its acuteness during active exercise, and immediately thereafter. No history of trauma could be elicited nor could the patient recall an acute onset. He was admitted to a Field Hospital in March, 1945, was processed through normal channels to the Zone of Interior, and was subsequently admitted to Percy Jones General Hospital, Orthopedic Service, on June 9, 1945, with a transfer diagnosis of "bone cyst."

Physical examination revealed moderate tenderness over the right ilium just posterior to the mid point of the crest and downward toward

* From Percy Jones General Hospital, Battle Creek, Michigan. Presented at the Staff Conference, Percy Jones General Hospital, April 12, 1946.

FIG. 1. Roentgenogram made the day prior to operation. Note the cystic area involving the right ilium with the obvious cortical rarefaction. Faint trabeculations are seen crossing the lesion. These merely represent ridges on the medullary surface of the cyst.

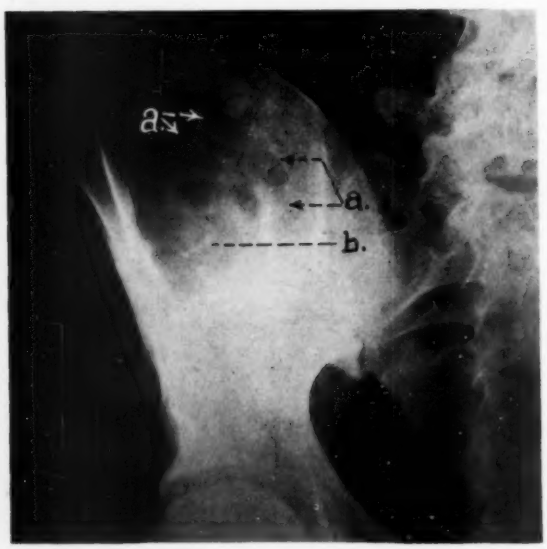

FIG. 2. Anteroposterior roentgenogram of right ilium showing the cystic lesion at *a* with trabeculated appearance at *b*. Cortical thinning and destruction resulting in decreased bone density is observed. Note the sharply circumscribed margins of the solitary unicameral cyst.

the acetabulum. Careful roentgenographic study of the entire osseous system failed to reveal evidence of pathologic change except for a bubble-like cystic lesion in the right ilium (Fig. 1 and 2). In the anteroposterior projection the lesion measured approximately 6.5 by 4.5 cm. (Fig. 2). The compact bone in this region was considerably rarefied and faint trabeculations, not unlike those seen in a giant cell tumor, were seen coursing across the lesion. The roentgen diagnosis was cystic lesion of the right ilium; possibly giant cell tumor, enchondroma, neurofibroma or primary malignancy of bone. Interval studies covering an eight-month period showed no change in size since our initial observations, thereby suggesting a benign lesion.

The laboratory examinations consisting of leukocyte and erythrocyte counts, hemoglobin determination, urinalysis, Kahn blood test, icteric index, sedimentation rate, phosphatase and uric acid blood determination were negative.

The patient was operated on by Colonel Francis M. McKeever, on October 15, 1945, under spinal procaine anesthesia. The operative procedure was as follows:

Operation: Biopsy of Tumor Mass, Right Ilium. An incision 30 cm. in length was made over the crest of the ilium and down onto the anterior aspect of the thigh. Skin and subcutaneous tissue were reflected moderately to expose the muscular attachments to the ilium. The gluteus medius and tensor fascia femoris muscles were stripped from the ilium extraperiosteally, cutting their fibrous attachments with a knife. The sartorius and iliacus muscles were stripped from the inner aspect of the ilium extraperiosteally with a knife, as far as the arcuate line. No protruding mass was found, either inside or outside the pelvis. A hole was then drilled vertically into the cancellous portion of the ilium, starting at the crest, adjacent to the roentgen-ray defect. At a distance of about 6 cm. from the crest of the ilium, the drill dropped into a cavity and blood-tinged fluid spurted from the drill-hole under pressure. The outer table of the ilium over the drill hole was removed, exposing a cyst-like cavity with no apparent fibrous tissue lining (Fig. 3). The cavity involved an area in which cancellous bone had apparently been de-

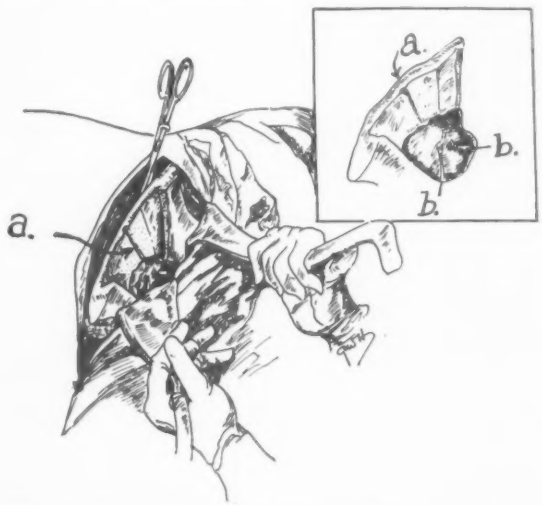

Fig. 3. Illustration showing operative approach to cyst. The upper margin of the lesion was 6 cm. below the iliac crest. The outer table of the ilium over the cyst has been removed. Note recessed drill hole through which fluid escaped under pressure. Insert shows appearance of incomplete septa at *b*. (Drawing furnished by courtesy of the Surgeon, Colonel Francis M. McKeever, Medical Corps.)

stroyed although there was no gross evidence of neoplastic tissue. The roof of this cavity, consiting of the outer table of the ilium, was completely removed and muscles allowed to fill the dead space (Fig. 4). Cultures of the fluid and

Fig. 4. Anteroposterior roentgenogram following operation on October 15, 1945. The operative defect extending to the iliac crest is noted at *a*—*a*. There has been no change in size or shape of the cyst which following decortication was filled with muscle.

the wall of the cavity were taken for bacteriological examination. The incision was closed by approximating the muscular attachments of the iliacus to the muscular insertion of the gluteus maximus and tensor fascia femoris muscle with interrupted sutures of chromic No. 1, and the skin was approximated with interrupted silk sutures. Pathologically, the lesion in the ilium appeared to be a benign cyst.

The tissue obtained at operation for examination consisted of triangular pieces of bone removed from the wall of the bone cyst of the right ilium. The cyst was smooth; it was lined with dense fibrous connective tissue and the wall consisted of gray-white bone. Surrounding this was the soft red cancellous bone. The microscopic examination of the tissue revealed a cyst consisting of dense bone with a wall composed of dense hyalin fibrous connective tissue only several layers of cells in thickness (Fig. 5).

Postoperatively the patient exhibits a mild degree of lordosis which is stated to have been present since childhood (Fig. 6 and 7). Following surgery at no time has he had low back pain or other symptoms referable to the spine. The mechanics of the skeletal system are apparently normal.

The patient's recovery has been uneventful, with complete relief of symptoms. Repeat roent-

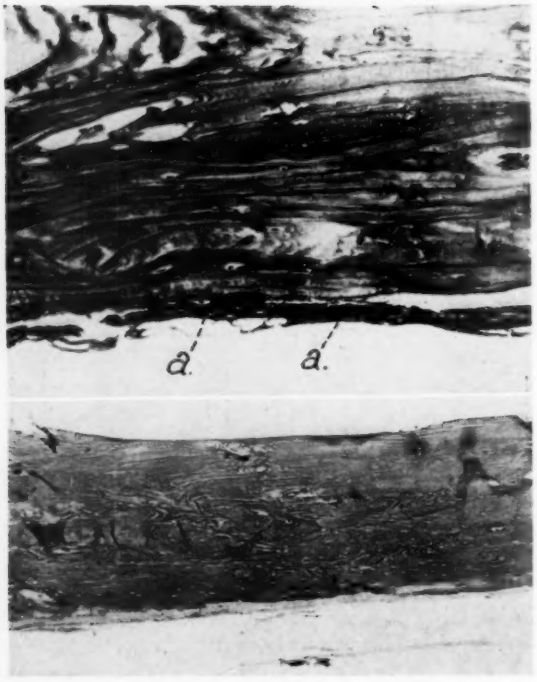

FIG. 5. Photomicrographs (X115, X30) showing cyst lined by thin layer of dense fibrous connective tissue at *a*. This layer is only four to five cells thick and has evidently become partially detached from the underlying bone. Except for the thin lining membrane the cyst wall is composed almost entirely of dense cortical bone. This in some areas shows loss of cellularity. Note the complete absence of osteoblastic and osteoclastic activity.

genograms fail to reveal additional skeletal lesions or increase in size of the bone defect.

COMMENT

Solitary bones cysts occur rarely in flat bones of the skeleton. For this reason when present in such a region they give rise to an interesting problem in roentgen differential diagnosis. One must consider the following possibilities:

a. Unicameral cyst
b. Giant cell tumor

FIG. 6. Lateral view of the patient showing slight abdominal protuberance which is in all probability incident to the lordosis as mentioned previously. These views were made four months following the operation.

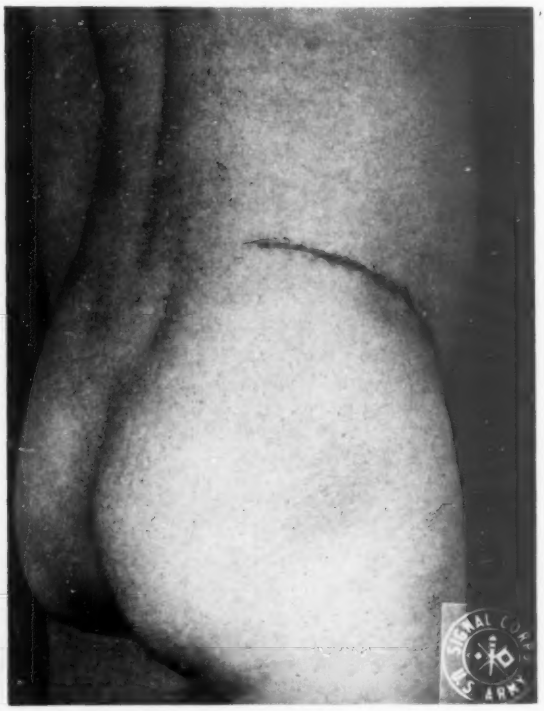

FIG. 7. The postoperative convalescence has been uneventful. The operative incision healed with first intention. This photograph shows a mild degree of lumbar lordosis. This condition has been present all his life and has at all times been asymptomatic.

c. Hyperparathyroidism
d. Polyostotic fibrous dysplasia
e. Solitary plasmocytoma
f. Eosinophilic granuloma
g. Neurofibroma
h. Primary or metastatic bone tumor
i. Xanthomatosis

Since biopsy was necessary before the true nature of the lesion could be determined, operation was performed. The ilium was drilled and fluid contents of a cyst escaped under pressure. Pathological sections revealed a unicameral cyst. The patient is now relatively asymptomatic following decompression of the lesion.

SUMMARY

1. Unicameral bone cyst occurs infrequently in the ilium and may thus cause difficulty in roentgen differential diagnosis.

2. Small septa in the walls of the cyst may give rise to a trabeculated appearance on the roentgenogram, closely simulating the roentgen picture of giant cell tumor.

3. The treatment of choice is usually surgical with decompression of the cyst and obliteration of the remaining dead space.

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AGENESIS OF THE VERTEBRAL BODIES — A CAUSE OF DWARFISM*

By MARGARET J. GIANNINI, M.D., FRANK J. BORRELLI,† M.D., *and* WILLIAM B. GREENBERG, M.D.

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TALBOT[8] uses the term "dwarfism" to designate children "moderately or markedly shorter than 90% of children in the community." The probable factors which he lists as being associated with dwarfism are hypothyroidism, anterior pituitary deficiency, malnutrition, excess adrenal cortical carbohydrate factor, renal dwarfism, progeria, "ovarian dwarfism," chondrodystrophy and allied conditions, and precocious skeletal maturation.

The term "agenesis" is used at this time in order to effectively express the incomplete number of segments and faulty development in the vertebral column. The occurrence in a four year old boy of multiple developmental defects of the vertebral column and thoracic cage, resulting in dwarfism, is of sufficient interest to merit a report.

Abnormalities in the model number of the seventeen thoracic and lumbar vertebrae are fairly common, but absence of several vertebrae with malformation of the chest is a rarity. Willis,[10] in a study of 748 spinal columns, found 5 cases with sixteen thoracic-lumbar vertebrae and 26 cases with three. The remaining 717 subjects showed the normal number of seventeen segments. Of these, 4 showed a lumbar increase in addition to a thoracic decrease, and 5 presented a lumbar decrease compensated by a thoracic increase, the total remaining unchanged.

As early as 1875, Goodhart[4] recorded a number of cases with malformations of the thorax associated with incomplete developments of vertebral segments. In one of these, a male sixty-four years of age, there was a fusion of the vertebrae from the seventh cervical to the fourth thoracic segments. The entire body of the first lumbar, the left half of the twelfth thoracic, and the right half of the second lumbar vertebrae were absent. In 1880 Willet and Wilsham[11] described a case in a woman, aged thirty-one, who presented a kyphoscoliosis in the upper thoracic region due to the absence of the first four and one-half thoracic vertebrae associated with absence of the third, fourth, and fifth right ribs.

Recently, Jarcho and Levin[5] reported 2 cases in siblings who showed complete and partial absence of vertebral bodies, a reduction in the number of ribs, a Klippel-Feil deformity, and fusion of other vertebrae. Both infants died during the first year of life.

Willard and Nicholson[9] enumerate cases with the following variations which have been observed in the vertebral column, viz.: "Fusion of the atlas to the occiput, fusion of the first three cervical vertebral bodies and of spines of the third, fourth, and fifth cervical vertebrae, fusion of the first and second cervical vertebrae with the third intact and fusion of the six upper thoracic, all cervical vertebrae fused in one mass with four cervical ribs and reduction of the thoracic vertebrae to eight, fusion of the first and second right ribs with two ribs arising from the fourth thoracic vertebra on the left side, and fusion of the fifth lumbar vertebra to the sacrum."

CASE REPORT

J. R., a male, aged four and a half, was admitted to Flower and Fifth Avenue Hospitals through the Out-Patient Department on October 22, 1945, with a history of cough, poor appetite, lethargy, vomiting, and diarrhea of three days' duration.

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† Director of the Department of Radiology.

The patient was born in Puerto Rico, and had arrived in the United States three weeks prior to admission. His delivery was spontaneous at full term, and his birth weight was $5\frac{3}{4}$ pounds. He was breast fed for the first six months of life. Dentition began at seven months of age, and he began to walk without assistance at fourteen months of age. The mother stated that he had been subject to coughing spells and had developed pertussis in 1944. She also volunteered the information that she had received antiluetic treatment for syphilis since 1944.

FIG. 1. Anterior view of the child showing the protuberant abdomen and the bilateral inguinal herniae.

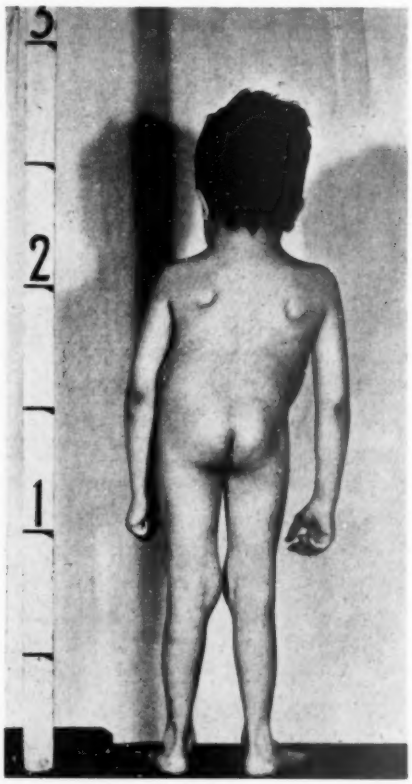

FIG. 2. Posterior view of the child showing the normal hair line and scoliosis.

Physical examination revealed a short, deformed child, appearing listless and moderately ill (Fig. 1). His temperature was 101°F., pulse rate 92, respiratory rate 20, and blood pressure 96/65. There was a profuse, serous discharge from both nostrils, and the tonsils were large and hyperemic. Examination of the chest revealed coarse rales over both upper lung fields on auscultation, with hyperresonance over these areas on percussion. The abdomen protruded markedly and the liver extended one finger's breadth below the right costal arch. The spleen was not palpable Bilateral indirect inguinal herniae were present. A moderate kyphoscoliosis was present. The spine was shortened and the lower ribs approximated the iliac crests. The chest was barrel-shaped, with a marked increase in its anteroposterior diameter (Fig. 2).

The height of the child was 83 cm. (33.9 in.); the circumference of the skull 48 cm. (19.6 in.); the circumference of the chest 50.5 cm. (20.6 in.); and the circumference of the abdomen 53.5 cm. (21.8 in.) (Fig. 3).

The laboratory findings on admission showed a leukocyte count of 11,500 with 40 per cent neutrophiles of which 4 per cent were immature, 22 per cent eosinophiles, 37 per cent lymphocytes and 1 per cent Turk cells. The erythrocyte count was 4,380,000 per low power field and the blood contained 11.7 grams of hemoglobin per 100 cc. The color index was 0.87. Examination

of the smear revealed slight poikilocytosis and anisocytosis. An occasional microcyte and macrocyte were seen. Urinalysis revealed a specific gravity of 1.020, a faint trace of albumin, a trace of acetone, 2–3 pus cells and 35–45 erythrocytes per high power field. The blood Wassermann, Schick and Vollmer patch tests were negative. The acid phosphatase activity was 2.1 King-Armstrong units and the alkaline phosphatase activity was 21.2 King-Armstrong

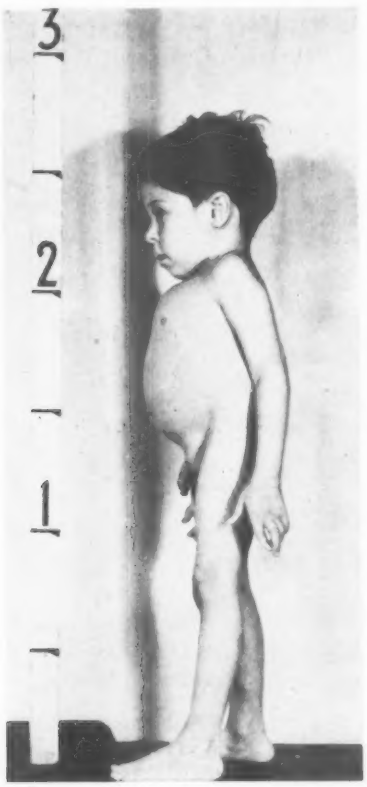

Fig. 3. Left lateral view of the child showing the marked anterior convexity of the chest and the abdomen protruding.

units (6–26 units normal for children). The blood phosphorus was 4.17 mg. and blood calcium was 10.30 mg. per 100 cc. The icteric index was 8 units and the Van den Bergh reaction was negative. Total blood proteins were 6.21 gm. per 100 cc. (albumin 4.24 gm.; globulin 2.67 gm.). The Hanger cephalin flocculation test was 1 plus. Examination of the feces revealed ova of *Ascaris lumbricoides*, *Trichuris trichiura*, and *Necator americanus*. No protozoan parasites were found.

Roentgenographic examination of the skull,

Fig. 4. Lateral view of the cervical spine. The cervical vertebrae show minor developmental variations in size, but are normal in number.

spine, chest, pelvis and extremities was made. The long bones showed normal development with no abnormality in the centers of ossification and epiphyses.

The cervical spine showed slight minor developmental variations with some irregularity in size and contour of the vertebral bodies which were normal in number (Fig 4).

The thoracic vertebrae showed multiple developmental anomalies with a decrease in number and definite abnormal development of those present. Partial and hemivertebral formation was observed; several of the segments showed lack of fusion. In a numerical equivalent only eight thoracic segments were present and none slowed normal development. There were only seven ribs on the left side and eight ribs on the right side with fusion of the vertebral ends of the right sixth and seventh ribs (Fig. 5). A moderate degree of dextroscoliosis was present with the maximum convexity at the dorsolumbar junction. Bending films showed very little motion in the region of the scoliosed portion of the spine. The lumbar spine showed normal development with slight incomplete fusion of the laminae of the fifth segment (Fig. 6). The

FIG. 5. Anteroposterior view of the spine, thorax, and abdomen. Note the marked irregularity in segmentation of the thoracic vertebrae, the reduction in the normal number of ribs with fusion of the posterior ends of the sixth and seventh right ribs. Note vertical diameter of thorax is diminished.

sacrum showed slight anomalous changes with incomplete development of the right half of the first segment with centers for only three sacral vertebrae. The centers of ossification of the coccyx were not present.

FIG. 6. Lateral view of the thoracic, lumbar, and sacral spines. Note the increased anteroposterior diameter of the thorax and abdomen.

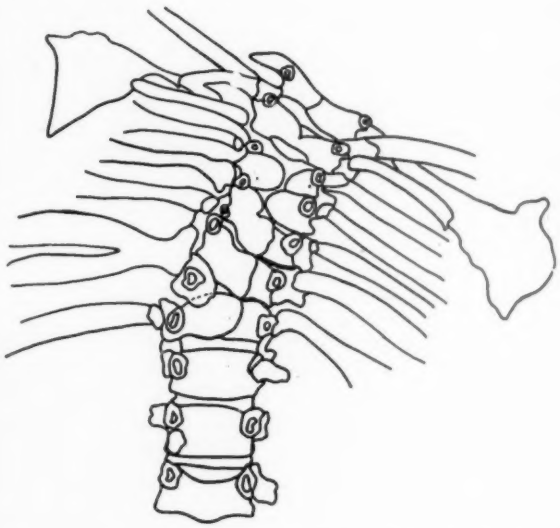

FIG. 7. Diagram of incompletely formed thoracic vertebrae and ribs as seen on the roentgenogram.

Roentgenograms were made of the skull, heart and lungs which revealed no abnormalities. After careful study of the embryological development of the spine, the exact nature and time interval of vertebral development cannot be ascertained. Therefore, from the roentgenogram alone it is impossible to identify the exact vertebral segments absent or malformed.

Roentgenographic study of the vertebral column of the nine year old brother of the patient showed no abnormal development of the vertebrae. The father of the patient was not available for roentgen examination (see Fig. 7 for diagrammatic scheme of Fig. 5).

The mother stated that no other members of the family had any noticeable body deformities.

The patient was treated symptomatically for his respiratory infection and diarrhea. Within two days his temperature had fallen to normal,

and he was markedly improved. He remained afebrile and alert until November 22, 1945. At this time he developed varicella and was transferred to a hospital for contagious diseases.

On May 1, 1946, the patient was readmitted for further study. At this time the leukocyte count was 9,800 with 65 per cent neutrophiles of which 15 per cent were immature, 30 per cent lymphocytes, and 5 per cent monocytes. The erythrocyte count was 4,000,000 and the hemoglobin content was 11.4 gm. per 100 cc. of blood. The specific gravity of the urine was 1.024, and the pH was 7.5. A very faint trace of albumin was present. The erythrocyte sedimentation rate was 16 mm. (micro-method, normal 1–9 mm. per hour). The urea nitrogen was 26.4, non-protein nitrogen 42.9, and cholesterol 164.5 (esters 78.4) mg. per 100 cc. of blood. Following one treatment with hexylresorcinol and magnesium sulfate no parasitic ova could be demonstrated after a week, and the child was discharged free of symptoms relative to his worm infestation.

COMMENT

According to Jarcho and Levin[5] malformations of vertebral bodies fall into two groups. The first represents malformations of the cervical spine, the Klippel-Feil deformity, with the triad of shortening of the neck, limited mobility of the cervical spines and a low hair line. The anomaly may vary from a cervical spina bifida and a reduction in the number of vertebrae to an irregular mass of fused vertebral bodies. At times there may be associated minor movements of the extremities, ocular palsies, local or general paralyses, and radicular pains. The second group is represented by malformations of the thoracic spine with resulting thoracic lordosis, convexity of the anterior chest wall, protrusion of the abdomen and approximation of the lower ribs to the iliac crests. In many of the latter cases the size of the thoracic cavity is reduced with limited pulmonary expansion resulting in rapid death from a superimposed lung infection.

The vertebral malformations in our case, although extensive, appear to be limited mainly to the thoracic and sacral vertebrae in contrast to the defects described by Jarcho and Levin in 2 infants who in addition showed the stigmata of the Klippel-Feil deformity. Apparently, the survival in our case is due to the fact that the vital functions of the brain stem were not interfered with by gross cervical spinal malformation. It is well to stress at this point that in children with deformities as described the usual consequence is early death. The reason for such deaths is the abnormal configuration of the thoracic cage, causing malposition of the essential organs such as the heart and lungs. In such instances as just stated, respiratory and circulatory functions are inadequately carried out and, accompanying the reduced pulmonary expansion with cyanosis and dyspnea, are followed by death. These children die for the most part from atelectasis followed by an infection early in life. Since there is no actual displacement of the heart and great vessels in our case, this is probably another factor for his life span having extended thus far. In retrospect it is possible that the minor pulmonary signs and symptoms of the patient on his first admission may be attributed to Löffler's syndrome or allergic pulmonic consolidation secondary to intestinal parasites. This consideration is taken in view of the 22 per cent eosinophilia, and stool findings of ova of *Ascaris lumbricoides*, *Trichuris trichiura*, and *Necator americanus*.

It is interesting to speculate on the etiology of vertebral malformations. The hereditary nature of the Klippel-Feil deformity has been noted in the families described by Sicard and Lermoyez[6] and by Demeler.[3] The cases of the former are of several generations and the 4 cases of the latter occurred in the same generation. The mother of the infants described by Jarcho and Levin[5] showed some minor vertebral defects. The mother of our patient showed no vertebral or other anomalies. The father, however, was not available for roentgen study. Although the mother of our patient was first noted to have syphilis in 1944 following the birth of the child, it is possible that she had the infection during her

pregnancy, which may have been responsible for the production of the faulty vertebral development in this patient. However, the child's Wassermann reaction has been negative on repeated examinations.

It is believed that the factors responsible for these vertebral malformations are (1) a general dysplastic tendency as is indicated by the frequency of various abnormalities in affected individuals or their relatives such as a cervical rib or accessory nipple, and (2) a specific dysplastic tendency resulting in the inhibition or necrosis of vertebral chondrogenic centers occurring before the eighth week of pregnancy. Bauer[1] presents a theory which will allow a sudden and unexplained formation or disappearance of vertebral segments. This he accomplished by the use of the terms intercalation and excalation which mean that the segments simply come or they go, at the stimulus of the germ cell, thereby explaining nothing. On the other hand, Streeter[7] claims that segmentation is not an intrinsic quality of the spinal cord, but is dependent rather on the relation with mesodermal somites especially with the vertebrae.

According to Cunningham,[2]

> A typical vertebra is ossified from three primary and five secondary centres. The three primary centers are one in the body and one in each half of the vertebral arch (called also the neural arch); the five secondary centres appear at the tip of the spine, the tips of the transverse process, the upper and lower surfaces of the body.
>
> The primary centres for the arch appear gradually from above downwards, appearing first in the upper cervical region about the seventh week of fetal life and reaching the sacrum about the twentieth week. They appear at the roots of the articular processes; the arch and its processes are ossified from them, and also the postero-lateral parts of the body—the parts of the body which in thoracic vertebrae articulate with the ribs.
>
> The centre for the centrum, i.e. the medium, larger part of the body, appears dorsal to the notochord, first in the lower thoracic region about the tenth week; the process spreads up and down till by the twentieth week centres have appeared in all the bodies except in the last two pieces of the sacrum, where they may not appear till the thirtieth week, and in the coccyx, where they do not appear till after birth. Occasionally there are two centres for the body which coalesce, but may fail to do so, so that in rare cases the body ossifies as two separate halves, or one half only ossifies.

Hence in considering this case with the already discussed views, the dorsal malformations have most probably occurred between the eighth and tenth week of embryological development. It can also be deduced that the manner in which the malformations occurred have not interfered with the subsequent normal development of the cervical and lumbar vertebrae.

In conclusion, the etiological factors for vertebral malformations have varied from improper intrauterine development due to trauma, intrauterine inflammation, irregularity in segmentation of the spine occurring early, lues, heredity, poor nutrition, endocrine disorders to any morbid condition interfering with the normal development of the fetus. It is an interesting speculation to attempt to catalogue a given case of dwarfism according to any one of these causes. However, in the case presented the vertebral malformations are responsible for the dwarfism even though no definite etiology of the primary origin for the malformations and the agenesis can be determined.

SUMMARY

1. A case is described of a dwarfed four and a half year old male with multiple developmental defects, viz., an incomplete development of the thoracic vertebral bodies with a complete lack of development of several segments. It is impossible to determine which specific vertebral bodies are affected and absent. Also noted is a synostosis of the vertebral ends of the sixth and seventh ribs on the right side. The development of seven ribs on the left side and eight ribs on the right side is present.

2. We would like to suggest vertebral malformations and agenesis of vertebral bodies as an additional cause of dwarfism.

Acknowledgment is hereby made to George Silverton, M.D. for his aid in the preparation of this paper.

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ISOLATED DISLOCATION OF THE LESSER MULTANGULAR BONE

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OF THE various injuries to the carpal bones one which has been observed rarely is isolated dislocation of the lesser multangular. A search of the literature has revealed only 8 cases previously reported. I have had occasion to make the roentgen diagnosis of this unusual luxation in 3 additional instances.

REPORT OF CASES

Case 1. The patient, H.A.P., a white male, aged thirty-eight, while employed at a shipyard slipped on a keel block December 19, 1942, falling on the extended right hand. Most of the force of the fall was taken on the heel of the palm and there was only slight hyperextension of the wrist. On arrival for roentgen examination there was a visible deformity of the wrist, a dorsal prominence opposite the proximal end of the second metacarpal bone associated with tenderness in this region and limitation of motion due to production of pain (Fig. 1).

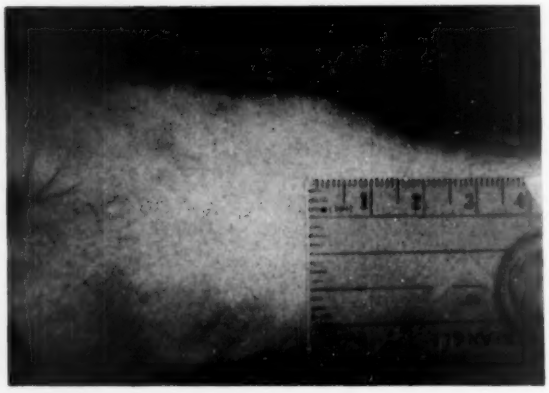

Fig. 1. Case 1. Photograph of injured right wrist. Note dorsal prominence opposite "zero" end of ruler, due to posterior displacement of lesser multangular bone.

The roentgen studies demonstrated a loss of normal anatomical relationship between the lesser multangular and the navicular bones as seen in the posteroanterior projection. The shadow of the former partially overlapped that of the latter. The oblique and lateral views showed that the lesser multangular had been displaced posteriorly. All the other carpal bones remained in normal position (Fig. 2).

Attempts at closed reduction under anesthesia were unsuccessful. At open reduction the roentgen diagnosis was confirmed. The displaced lesser multangular was restored to normal position but reduction could not be maintained. The bone, however, was not excised because the surgeon feared that its removal would cause greater disability than leaving it dislocated.

Case 11. A white male, M.L., aged twenty-nine, employed at the same shipyard as Case 1, fell from a wooden horse and struck his hand against a bulkhead September 22, 1943. As in Case 1 there was a deformity posteriorly in the carpal region just proximal to the second metacarpal bone. The roentgen examination (Fig. 3) similarly showed a partial overlapping of the shadows of the lesser multangular and navicular bones with loss of the normal intervening line of articulation which should be seen in the posteroanterior view. The lateral projection showed a dorsal prominence in the distal carpal region (not present in the uninjured wrist) similar to that observed in Case 1. The findings were interpreted as indicating a posterior dislocation of the lesser multangular in relation to the navicular.

Operation confirmed the roentgen diagnosis. There was a posterior dislocation of the lesser multangular on the navicular. Because the bones could not be restored to normal anatomical position the surgeon excised the lesser multangular. (This patient was treated by a different surgeon from that of Case 1.)

Case 111. A colored male shipyard worker, R.A., aged twenty-five, fell while running and struck his left hand on the ground January 26, 1945. The roentgen examination showed, as in

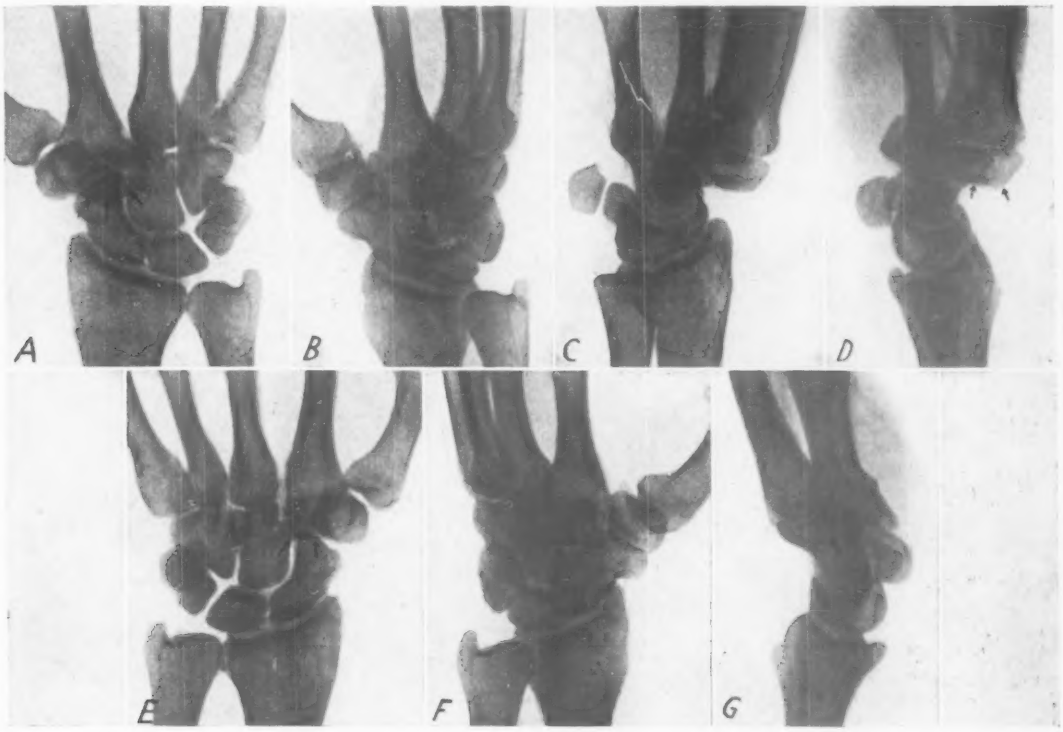

Fig. 2. Case 1. *A*, *B*, *C*, *D*, injured right wrist; *E*, *F*, *G*, normal left wrist. Note overlapping of lesser multangular and navicular in (*A*) by comparison with (*E*). In (*F*) note less of capitate is hidden than in (*B*) where lesser multangular is dislocated dorsally and proximally. In (*C*) and (*D*) note marked dorsal prominence of lesser multangular producing characteristic deformity; compare with (*G*) in which such prominence is absent.

Cases I and II, a dorsal and proximal displacement of the lesser multangular bone in relation to the navicular (Fig. 4). Closed reduction was performed and subsequent studies showed the dislocation completely reduced.

COMMENT

The lesser multangular bone articulates distally with the second metacarpal, proximally with part of the distal surface of the navicular, to the radial side with the greater multangular and to the ulnar side with the capitate. Its dorsal surface is much larger than its volar; thus this bone is somewhat wedge shaped. With the occurrence of dislocation it would be natural for the bone to be displaced dorsally. This has been the type of dislocation in the 3 cases herewith reported and, with the exception of that of Wahlers,[8] in all the cases previously reported.

The first recorded case of dislocation of the lesser multangular bone is that of Gay[3] (1869). The patient had injured his wrist in striking a companion on the shoulder. The diagnosis was made on the basis of the deformity, a marked prominence of the wrist posteriorly just proximal to the second metacarpal bone. From Gay's description there seems no doubt of the accuracy of the diagnosis, which in each of the cases subsequently reported in the literature was verified by roentgen examination. The first case in which the roentgen rays were used for diagnosis was that of Sheldon[6] (1901) who states, "The fluoroscope was used and showed the injury to be a simple dorsal displacement of the trapezoid." His paper is illustrated by a "skiagraph showing dislocated trapezoid." The figure is a lateral view; the detail in the reproduction of this early roentgenogram does not permit veri-

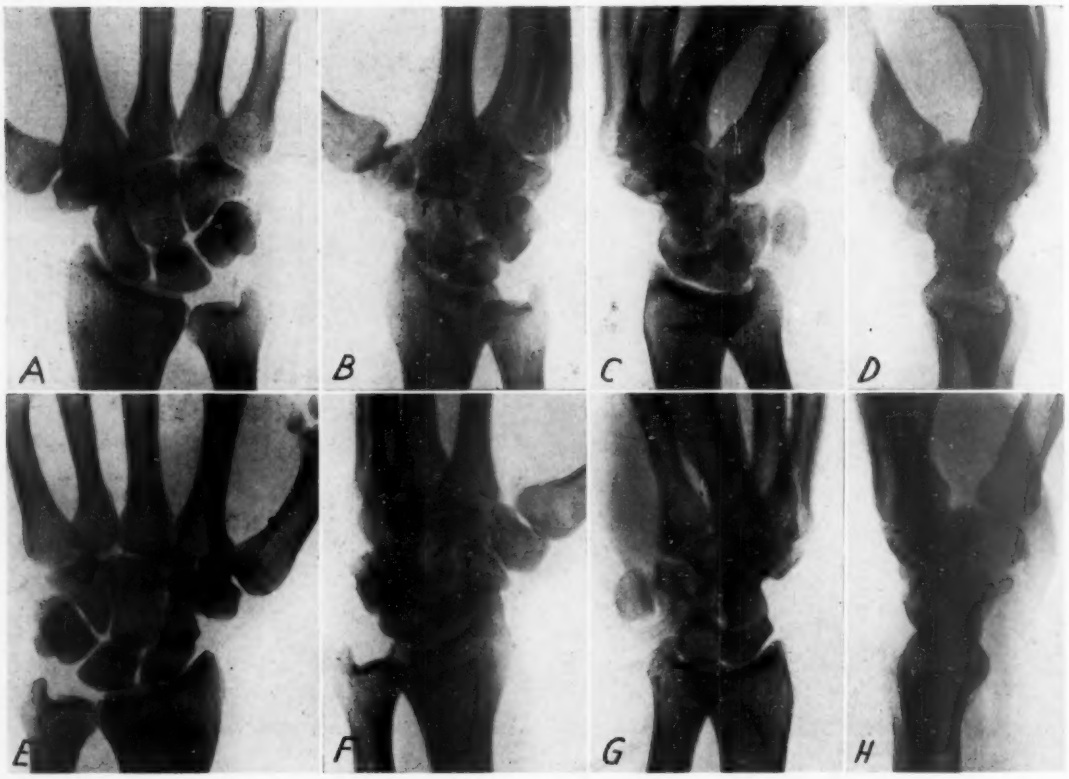

FIG. 3. Case II. *A, B, C, D,* injured right wrist; *E, F, G, H,* normal left wrist. The dislocation is less than in Case I; there is less overlapping of lesser multangular and navicular. In (*C*) the lesser multangular can be seen posterior to distal end of navicular by comparison with (*G*). A comparison of (*D*) and (*H*) demonstrates the same feature although recognition is more difficult because of the numerous superimposed shadows.

fication of the diagnosis but the description of the deformity is so typical as to establish the case as authentic.

Frank[2] in 1925 reported the case of a Dutch workman riding a bicycle whose right handlebar collided forcibly with a lamp post. The impact caused the handlebar to be suddenly twisted inwards; the victim fell but retained his grasp on the handlebars. His physician found, in addition to loss of power of grasp, a bony hard mass at the proximal end of the second metacarpal. Roentgen examination showed a dorsal dislocation of the lesser multangular; this bone was rotated so that its proximal concave surface faced radially. Treatment was by manipulation and the application of a pressure pad. Six months later the bony hard deformity was still present, the snuff box was missing, dorsal flexion was very restricted and abduction of the hand was practically impossible. Roentgen examination at this time was interpreted as showing some atrophy of the lesser multangular. Frank discussed in considerable detail the mechanics of the articulations of the wrist. He pointed out that in the position in which the hand is placed in grasping the handlebar of a bicycle, in adduction and ulnar flexion and the thumb in opposition and flexion, the greater multangular and the capitate tend to become approximated, squeezing the lesser multangular. Thus the position of the bones would predispose to dislocation.

In 1931 Wahlers[8] reported the only case in the literature in which the lesser multangular bone has been dislocated in the volar direction instead of dorsally. This is clearly shown by his lateral film. His posteroanterior view shows the lesser multangular partially overlapping the capitate

but not overlapping any portion of the navicular. His postreduction films show normal relationships re-established and afford an adequate normal for verification of his diagnosis. Fantoni[1] (1938) included an excellent photograph showing the deformity. His roentgenograms show only mild overlapping of the navicular, similar to Case II presented herewith; there was no overlapping of the capitate. Slany[7] (1939) added a case, presenting posteroanterior and oblique views. Peterson[5] (1940) reported a lesser multangular dislocation, shown to be posterior by the oblique views. At operation the bone was found to be broken into three fragments "which lay in a horizontal position as compared to the normal perpendicular position." The fragments were removed.

Milch[4] (1943) reported an additional case and reviewed the literature (citing all the above listed cases except that of Fantoni). He pointed out that this dislocation is associated with a rupture of the dorsal ligament even when this ligament is well developed, disagreeing with Sheldon who following experiments on cadavers had suggested a congenital weakness of the dorsal ligament as predisposing to such a dislocation. Milch stated that treatment may be conservative or surgical. Although the bone may be left unreduced, or be removed, without any necessarily disabling consequences, he considered that the method of choice is open reduction. Another interesting point was observed in his case. Roentgen examination three months after open reduction showed marked increase in the density of the replaced lesser multangular. This was interpreted as indicating ischemia due to rupture of blood vessels.

Of the various projections which can be used in the roentgen examination of the wrist, the most valuable for demonstrating dislocation of the lesser multangular is the ordinary posteroanterior view. The oblique views and particularly the lateral view are rather confusing with their numerous super-

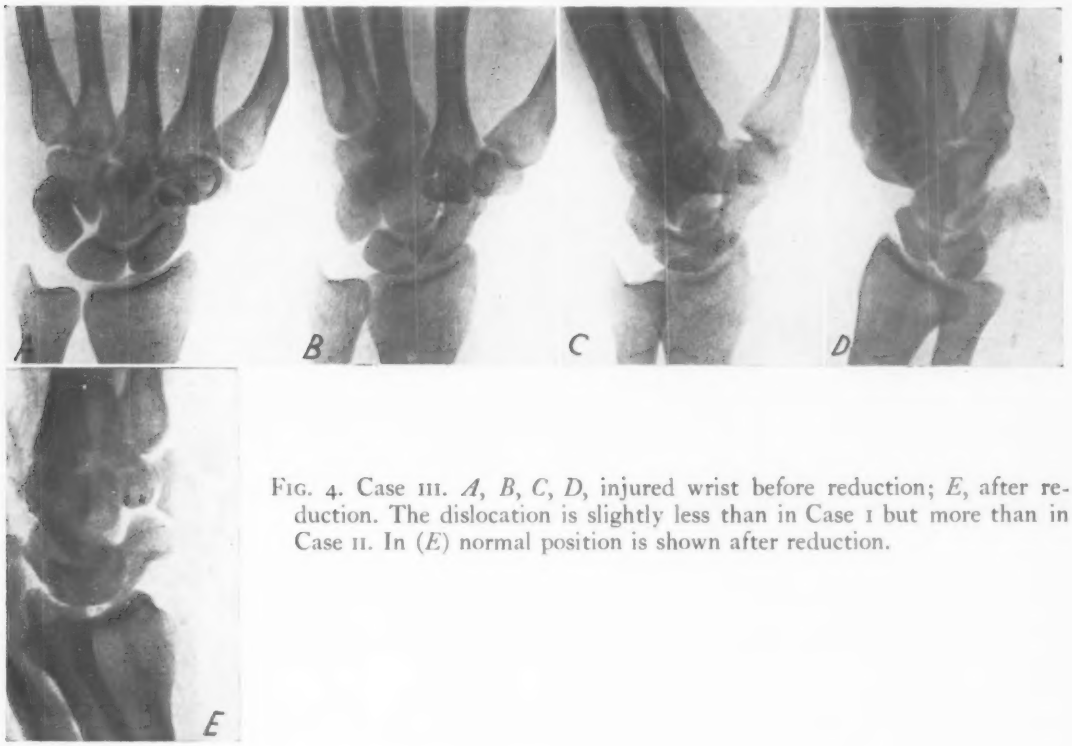

Fig. 4. Case III. *A*, *B*, *C*, *D*, injured wrist before reduction; *E*, after reduction. The dislocation is slightly less than in Case I but more than in Case II. In (*E*) normal position is shown after reduction.

imposed shadows (as can be readily noted in the figures) but they are at times of value and should always be exposed. Normally in the posteroanterior view there is a clear joint space between the distal aspect of the navicular and the two multangular bones, with which it articulates. When the lesser multangular is dislocated posteriorly there is also some proximal displacement so that it overlaps the navicular; thus the clear line of the normal articular space is lost. There may be in addition some ulnar displacement producing slight overlapping of the capitate. The degree of dislocation renders the overlapping of the navicular somewhat variable. In Cases I and III the diagnosis is easily made from the posteroanterior projection. In Case II there was considerably less overlapping in the roentgenograms and only a slight dislocation was found by the surgeon; in this case the oblique views, when compared with the normal wrist, were of much help in establishing the diagnosis. It should also be borne in mind that even in the normal wrist there may be slight apparent overlapping of the lesser multangular and the navicular. This is due to the slight obliquity of the plane of articulation between the navicular and the multangulars. It should not be confused with dislocation; painstaking comparison with the normal wrist may be necessary to avoid error of interpretation.

SUMMARY

To the series of eight cases of dislocation of the lesser multangular bone previously reported, three new cases are added.

The injury is associated with a rupture of the dorsal ligament.

Even at operation it may not be possible to secure reduction. Ischemic increase in bone density may follow, in spite of satisfactory reduction.

The roentgen diagnosis is made by observation of overlapping of the shadows of the lesser multangular and navicular bones. Oblique and lateral projections are of assistance.

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GRANULOSA-CELL TUMOR OF THE OVARY

WITH SPECIAL REFERENCE TO RADIOSENSITIVITY*

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WITH well over 500 cases of granulosa-cell tumor now reported in the literature, present-day clinicians and pathologists have at their command an ever-increasing volume of knowledge concerning the origin, biologic history and pathologic aspects of this gynecologic "new comer." Norris[19] wrote, "The granulosa-cell carcinoma may be defined as a malignant tumor of the ovary whose histologic structure commonly and characteristically shows the presence of granulosa-like cells which manifest a tendency to surround more or less typical follicles. The tumor is associated with signs and symptoms which may be ascribed to degrees of hyperestrinism." As is true of arrhenoblastoma, it is these hormonal effects which give to the tumor its particular biologic importance.

Treatment has been for the most part surgical, and the results have been remarkably good when the tumor was unilateral (95 per cent of cases) and encapsulated. However, study of recent literature reveals that the use of roentgen rays in the treatment of this tumor has, for the most part, been neglected. This observation has all the more significance when it is considered that roentgen therapy has long since proved its worth in the more frequent types of pelvic malignant processes.

NATURE OF THE STUDY

We wish to present data accruing from a series of 50 granulosa-cell tumors which were studied at the Mayo Clinic from 1905 to 1943, and which have been reported in detail previously. The present report will deal primarily with the radiotherapeutic aspects in 11 cases of the 50; the clinical and pathologic data in 7 cases are added and summarized in tabular form merely for purposes of completeness. Four other cases, to bring the total to 11, are reported in the text.

HISTOGENESIS

The problem of the histogenesis of this tumor is still unsettled. Some authors still support Robert Meyer's view that the tumor cells arise from the granulosa-cell rest (Granulosaballen) or undifferentiated cells left over from the early oophorogenetic phase of ovarian development. Others believe that the tumors arise from the granulosa of the follicles, and cases have been reported which seem to substantiate this view. Fischel[9] and his followers[24] thought that granulosa-cell tumors arise from the primitive mesenchymal core of the ovary, rather than from the germinal epithelium. Novak,[21] previously an advocate of Meyer's ideas, said in 1941 that they must be modified and that the work of Fischel, Politzer and others had shown clearly that both granulosa and thecal elements are formed by the differentiation of ovarian mesenchyma in situ.

HORMONAL STUDIES

Fairly extensive hormonal studies have established the fact that granulosa-cell tumors secrete estrin or folliculin. Schulze[25] wrote that the demonstration of large

* Partial abridgment of thesis submitted by Dr. Moreton to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Radiology.

amounts of estrin in the urine, in cases of suspected granulosa-cell tumor, may become as important for diagnostic purposes as is the Aschheim-Zondek reaction in cases of suspected hydatidiform mole and chorionepithelioma.

Granulosa-cell tumors have been produced experimentally by Furth and Butterworth, and Geist, by subjecting mice to general irradiation. Mice in which these tumors have developed exhibit many signs similar to those noted in human beings who have such tumors. However, we think that irradiation of the ovaries in the human being probably does not predispose to the development of granulosa-cell tumors, since we have been unable to find any report of the development of such a tumor in a woman who had previously received irradiation.

HISTOPATHOLOGIC ASPECTS

Microscopically, in any given case, the individual cells are uniform, regardless of the primary pattern of the tumor. The cells are typically small, oval or round, with clean-cut outlines, eosinophilic cytoplasm and large, dark-staining nuclei with small nucleoli. Mitotic figures are rarely seen.[2,4,8]

COURSE OF DISEASE

A more malignant course is indicated grossly by adhesions, bilateral occurrence of the lesion and rapid growth and rupture of the capsule. Microscopic criteria for malignancy have not been clearly defined, but metastasizing examples are often anaplastic.

Metastasis is found increasingly as the patients are followed over longer periods after operation. Schulze[26] observed this and, moreover, pointed out that late recurrences have led to death many years after the supposed cure of a seemingly benign condition. Spread usually occurs by direct extension, and usually takes place within the abdominal cavity, although distant metastasis, including extension to the brain, has been reported by Klaften and McCartney.

ASSOCIATED CONDITIONS

Other pathologic conditions are associated with granulosa-cell tumor fairly frequently. The most common of these are endometrial hyperplasia, uterine fibroids, subinvolution, adenocarcinoma of the body of the uterus, carcinoma of the breast and endometriosis. One is almost forced to believe that these conditions are of hormonal origin; that is to say, induced by the presence of granulosa-cell tumor rather than being merely coincidental findings.

RADIOSENSITIVITY

From a review of the literature it is difficult to draw conclusions about the radiosensitiveness of granulosa-cell tumors. Schulze[26] pointed out that most of the reports on inoperable, incompletely removed or recurrent tumors which disappear after roentgen-ray trratment are made too soon after treatment for the reporter to be able to know what the final outcome will be. Studdiford reported a case in which a sixty-seven year old woman with vaginal bleeding underwent dilatation and curettage on June 7, 1933, after which 100 mg. of radium was placed on the uterus for thirty hours. A small fibroid tumor on the right side of the uterine fundus was then discovered. A year later, examination revealed a cyst of the left ovary the size of an orange. The patient refused to undergo operation. When she was seen by Studdiford, on March 1, 1935, twenty-one months after the original radium treatment, the patient had been bleeding for a month. Ten days later, laparotomy was performed and a tumor 14 by 11 cm. was removed from the left ovary. Studdiford called attention to the fact that 3,000 mg-hr. of radium usually is sufficient to destroy completely the follicular system in the ovaries of a young woman; the tumor which this patient had and which had received a similar dose of radium was large enough to be apparent on abdominal inspection. He concluded that whereas radium in large doses

is very destructive to the normal follicular system, it does not have the same effect on neoplastic granulosa cells.

Schulze's[25] second case was similar. In April, 1921, the patient had complained of irregular bleeding. The left ovary was the size of an English walnut. After dilatation and curettage, a dose of 596 mg-hr. of radium had been administered to the uterine cavity. Six years later, in June, 1927, the patient returned because she had been flowing for six months and had become very anemic. After dilatation and curettage, the cervix was resected, and radium was inserted into the uterus for a dose of 1,214 mg-hr. The patient was seen again in December, 1931, three and a half years after her second admission and more than ten years since her first admission. She had been fairly well since her previous treatment; her periods had been irregular, but her general condition had been better than formerly. Two days after her admission a granulosa-cell tumor was removed. Schulze[26] called attention to the cases of Habbe and Dworzak, in which the tumors had been reported as responding to roentgen treatment. She also referred to Schiffmann's second case in which an incompletely removed tumor had continued to grow. She concluded that, in rare cases in which complete surgical removal of the tumor is not possible, postoperative radiotherapy may increase the patient's chance of cure.

Novak and Brawner[22] wrote that in view of the sensitiveness of granulosa tissue to radiation, granulosa-cell tumors likewise should respond well to radiotherapy. Dockerty and Masson[6] believed that evidence is accumulating to show that these neoplasms are radiosensitive. Wolfe and Kaminester[31] said that granulosa-cell tumors involute favorably after roentgen and radium treatment. Klaften pointed out that both granulosa-cell tumors and the granulosal epithelium of the normal ovary have an exceptional sensitiveness to irradiation. Dworzak reported on a tumor which had been operated on, and added that for the sake of safety, postoperative roentgen treatment had been administered to the patient through two anterior pelvic and two posterior pelvic fields, each of which received 650 r. He declared that the evident radiosensitiveness of the tumor has great therapeutic value, and that, in function as well as in radiosensitiveness, the tissue of granulosa-cell tumors appears to be similar to that of ordinary ovarian follicles. Stewart and Farrow said that although certain malignant, metastasizing, granulosa-cell carcinomas have proved to be radiosensitive, most of them are removed surgically, and for this reason there is not an opportunity to observe the effect of irradiation with sufficient frequency to make it possible to formulate definite ideas on this point.

Schiffmann said that since these tumors are composed of granulosa cells, they should be influenced by roentgen rays. He referred to the tumor reported by Meyer which had been irradiated by Phillips, and wrote that its radiosensitiveness was clearly demonstrated. However, in Schiffmann's fourth case, in which the patient had undergone an incomplete operation, the tumor grew rapidly while it was being treated with roentgen rays. Schiffmann, however, did not give the details of the treatment in any of his cases.

Wolfe and Kaminester[32] reported that irradiation of granulosa-cell tumors supposedly is followed by favorable involution of the neoplasms, but results of their investigation of a few cases cited in the literature have not substantiated this assumption. They concluded that the influence of irradiation on granulosa-cell tumors is somewhat varied and uncertain but they emphasized the point that closer study of dosage and end results is necessary for arrival at a final opinion. The patient in the second case included in their report was a fifty-three year old woman who had begun to bleed from the vagina eight years after the menopause. In September, 1925, dilatation and curettage had revealed hyper-

plasia of the endometrium. One hundred milligrams of radium had been placed in the uterus for eighteen hours. Two weeks later, profuse vaginal bleeding had recurred but this had been checked by two sessions of roentgen treatment. The patient had been examined by the authors in June, 1926, and uterine scrapings again had showed endometrial hyperplasia. Seventy-five milligrams of radium had been inserted into the uterus for twenty-four hours (1,800 mg-hr.). Then the patient had been well from July, 1926, until February 15, 1929, at which time cramplike pain in the abdomen had developed. A diagnosis of "pyometria" had been made and then, at dilatation and curettage, 200 cc. of blood and pus had been evacuated. On March 7, 1929, supravaginal hysterectomy was performed and three sessions of postoperative roentgen treatment were carried out. The factors were said to have included a 20 by 20 cm. suprapubic field, 185 kv., 4 ma., 2.5 mm. copper and 1 mm. aluminum filters, 50 cm. distance and twenty-five minutes' time, with a total of 300 r administered at each sitting. When the patient was examined a year later, evidence of abnormality was not found.

Traut and Marchetti, in their series of cases, presented 2 instances in which radium had been introduced into the uterus. One patient had received a dose of 1,200 mg-hr. of radium. This had been followed, twenty months later, by surgical removal of a "benign" granulosa-cell tumor. The second patient had received 3,600 mg-hr. of radium and, some months later, a granulosa-cell tumor had been removed. The authors concluded that irradiation of this kind does not prevent the appearance of a tumor or destroy a tumor that is already present. Of the 8 patients reported by Traut and Marchetti to have had a malignant tumor, only one survived four years, and this patient had received postoperative roentgen-ray treatment. Five other patients had received "deep x-ray" treatment, but they died within fourteen months. Traut and Marchetti believed that roentgen therapy does not effectively retard the growth of granulosa-cell tumors.

McDonough reported an interesting case in which a fifty year old colored woman had entered Kings County Hospital on February 11, 1936, complaining of a small lump in an old abdominal scar; this lump had varied in size and had sometimes been tender. She had had chills, fever, nausea and vomiting, loss of weight and a dragging pain in the back. She had not had vaginal bleeding. Vaginal examination had revealed a large, soft mass in the cul-de-sac of Douglas. When the patient was operated on, a small, dark red, friable mass in the incision, three masses in the abdominal cavity, and a moderately enlarged uterus were found. The first mass in the right ovary and the second, smaller mass which adhered to the sigmoid, were removed. The third and lower mass was found to be deeply embedded, and could not be removed. The diagnosis was granulosa-cell tumor of the ovary, with metastasis. Beginning on March 3, 1936, the patient received ten sessions of roentgen treatment, each of 200 r, at a distance of 40 cm. Seven months later (September 26, 1936), this patient said she felt well, that she had gained 15 pounds (6.8 kg.) and had a good appetite. The abdomen was found to be normal, and pelvic examination had revealed only a relaxed perineum.

Schulze[26] referred to Vogt, to Smith and to an unpublished report from the Memorial Hospital. She wrote that the authors concerned thought that roentgen rays might be the etiologic agent in the production of granulosa-cell tumor, because in experimental work with mice the workers had found that roentgen rays at first depress and subsequently stimulate the growth of granulosa cells to such a degree that formation of tumor results. They thought it would be wise to limit the employment of roentgen rays in women to conditions of such urgency as would justify the use of roentgen therapy despite this possible effect.

One of the most interesting reports in

respect to roentgen treatment is one made by Kleine in 1933; the same case had been reported five years previously by Werner. One patient was an eighteen year old student from whom a primary ovarian tumor had been removed on September 6, 1919. Two years later a large, metastatic tumor had formed in the left side of the abdomen and had disappeared after 1 unit skin dose of roentgen rays. One year afterward (1922) the tumor had recurred, but had disappeared again after 1 H.E.D. When the patient was seen by the authors in 1923, she complained of increasing pain through the body, but particularly in the epigastrium. In spite of previous roentgen treatment, the pain had increased to an unbearable point. Both legs and the muscles of the perineum were found to be completely paralyzed, the patient had complete retention of urine, and a palpable tumor in the epigastrium was discovered. In spite of previous treatment, she had suffered from menorrhagia. Between May 8 and 18, 1923, roentgen treatment was administered to the anterior and posterior aspects of the abdomen, 170 kv., with 0.5 mm. zinc filter, 50 cm. distance, divided into thirds of 1 H.E.D., front and back, six sessions of treatment having been administered in nine days. The condition of the patient having improved, twenty-five sessions of electrical treatment were administered to the leg muscles, and on June 6 the patient was able to walk, although she was somewhat unsteady. The pain was relieved almost immediately. On June 19 a tumor in the right ileocecal region was discovered and the patient was treated as before. Also, on June 22 and 25, roentgen treatment to the epigastrium was repeated. On August 29 the patient complained of marked difficulty in breathing. Roentgenologic examination showed, in the substernal portion of the mediastinum, a tumor the size of a fist. The anterior and posterior aspects of the thorax were immediately irradiated with the same factors as before, each field receiving half a skin unit dose. Kleine described the treatment as intensive cross-firing with 1 H.E.D. given in fractions to an anterior, a posterior and two lateral fields.

The patient remained apparently healthy until June, 1925, when new nodes appeared in the lower part of the abdomen. Moreover, a retroperitoneal tumor larger than a fist appeared to the left of the spinal column and extended upward from Douglas' pouch to fill the pelvis. This time, treatment was administered to the lower part of the abdomen, between the navel and the symphysis, on the left and right sides, each field receiving 1 H.E.D., 200 kv., 3 mm. zinc and 1 mm. aluminum filtration, at a distance of 23 cm. The dose was divided into quarters, and a third sacral field was treated at a distance of 50 cm., with 1 H.E.D. At the time that Kleine wrote, eight years after the roentgen-ray treatment and fourteen years after the operation, the patient was well and able to work. Kleine said the patient realized that her favorable progress was due to the roentgen-ray treatment, but he added that large doses had been necessary to produce it.

REPORT OF CASES

All the following cases have been reported previously, but in the earlier reports irradiation had been mentioned only as a part of the treatment, and no emphasis had been placed on it. We shall present 4 in the section subjoined; the remaining 7 are summarized in Table 1.

Eleven of the fifty patients concerned received irradiation. One was treated by a menopausal dose of radium. The remaining 10 received radiotherapy as a postoperative measure or for treatment of metastasis or other type of spread of the neoplasm.

Case 1.* The patient treated by a menopausal dose of irradiation was a fifty-nine year old white woman who had menstrual irregularity. On October 19, 1927, dilatation and curettage were done, in association with the insertion of radium (1,200 mg-hr.) designed to hasten the onset of complete menopause. The pathologic report on the curetted tissue was "hypertrophic endometrium." This patient returned in June,

* Previously reported by Dockerty and MacCarty.[5]

TABLE I

SALIENT DATA: SEVEN CASES OF GRANULOSA-CELL TUMOR IN WHICH TREATMENT WAS ROENTGENOLOGIC*

Case	Age	Tumor before or after menopause	Pregnancies	Previous treatment	Symptoms	Examination	Operation	Result
V†	54	After	1	Radium 2 months before biopsy.	Bloody discharge 4 mos. previously, for 2 mos. None since radium therapy, but pain in pelvis.	Presystolic murmur; uterus enlarged with fixed irregularity to left.	Total abdominal hysterectomy. Bilateral salpingo - oophorectomy. Roentgen treatment postoperatively.	Well fifteen yrs. postoperatively.
VI‡	72	After	4		Discharge with bad odor, 2 wks.; menstrual period followed above. Constipation.	Polyp in cervix; uterus enlarged 3 to 4 times; irregular.	Bilateral salpingo-oophorectomy. Total abdominal hysterectomy. Roentgen treatment postoperatively.	Died 5 yrs. postoperatively. Recurrence in liver (said to be metastasis to liver).
VII	37	Before	3		Menses prolonged from 3 to 5 wks. for previous yr. Amenorrhea for 4 yrs. previously. Occasional spotting between menses.	Fundus 3 times normal size. Cystic mass in left side of pelvis filling posterior of cul-de-sac of Douglas.	Total abdominal hysterectomy. Bilateral salpingo - oophorectomy. Roentgen treatment postoperatively.	Well 13 yrs. postoperatively.
VIII‡	59	Before?	0		Periods irregular and profuse for 5 yrs. Frequent severe hemorrhages for 3 yrs. Weak.	Fundus enlarged 3¼ times. Irregular pelvic mass. Marked anemia.	Total abdominal hysterectomy. Bilateral salpingo - oophorectomy. Roentgen treatment postoperatively.	Well 11 yrs. postoperatively.
IX‡	63	After	2	Dilatation and curettage; polyp removed 6 mos. previously.	Menopause 10 yrs. previously; bleeding began 6 mos. previously. Dilatation and curettage and removal of polyp 6 mos. previously. One mo. later until seen, frequent slight bleeding.	Blood pressure 180/100. Large fibroid on right. Mass on left?	Total abdominal hysterectomy. Bilateral salpingo - oophorectomy. Appendectomy. Roentgen treatment postoperatively.	Well 10 yrs. postoperatively.
X†	56	After	2		No bleeding since menopause until 4 mos. before seen. Bleeding then became profuse. Pain to right lower abdominal quadrant. Nausea and vomiting.	Tenderness in lower part of abdomen. Resistance in right lower abdominal quadrant. Fundus freely movable. Left adnexal mass.	Total abdominal hysterectomy. Bilateral salpingo - oophorectomy. Roentgen treatment postoperatively.	Well 10 yrs. postoperatively. Examined at Clinic June 2, 1946.
XI†	42	Before	3		Amenorrhea 10 mos. Apparently normal 9 mos. Heavy flow since, with more or less continual flow. Abdomen enlarged for 4 to 5 mos.	Large mass filling entire abdomen. Fundus enlarged. Small fibroids.	Total abdominal hysterectomy. Bilateral salpingo - oophorectomy. Appendectomy. Roentgen treatment postoperatively.	Well 1½ yrs. postoperatively.

* Cases I through IV are reported in the text.
† Previously reported by Hodgson, Dockerty and Mussey.
‡ Previously reported by Dockerty and MacCarty.

1930, stating that vaginal bleeding had not occurred from October, 1927, to January, 1930. Surgical exploration revealed a hemorrhagic tumor, 8 cm. in diameter, of the right ovary. Microscopically, the tissue of this lesion was typical of granulosa-cell tumor. The left ovary was fibrocystic and atrophic.

CASE II.† The second patient received, vaginally, a total of 2,100 mg-hr. of radium for treatment of extension of the tumor into the pelvis. A single dose of 700 mg-hr. was administered through the cul-de-sac of Douglas and in

† Previously reported by Dockerty and MacCarty.[3]

right and left transverse positions in the vagina. This patient was in good health twelve years after this treatment. She died sixteen years after her operation, but we do not know the cause of death.

Case III. The third patient received a combination of radium and roentgen-ray therapy for a grade 2 adenocarcinoma of the body of the uterus and a grade 2 malignant granulosa-cell tumor of the ovary. Radium was introduced into the cul-de-sac of Douglas on two occasions at three day intervals for a total dose of 1,370 mg-hr. In addition, roentgen-ray irradiation was administered through four pelvic fields (one anterior, one posterior and two lateral), each field about 20 by 20 cm. The factors were 200 kv., 5 ma., 0.75 mm. of copper and 1 mm. of aluminum filtration, 50 cm. distance, and the time was one hour and ten minutes, making a total surface dose of about 560 r per field. These treatments were repeated twice at three month intervals. The patient was well with no evidence of recurrence nine years later.

Case IV.* The fourth patient at surgical exploration was found to have a ruptured ovarian cyst associated with a granulosa-cell tumor. Postoperative roentgen-ray therapy was administered to one large anterior field and one posterior pelvic field, with the same factors as those listed in Case III. Each field received 580 r, measured in air. Later, the patient received additional roentgen-ray therapy at home. Six years afterwards, this patient returned with symptoms of obstruction. At operation it was necessary to remove 40 cm. of small bowel containing metastatic nodules. She then received additional roentgen-ray therapy to two upper abdominal fields and to one posterior field at the same level with the same dose as before. One more course of irradiation was administered to her on a subsequent visit. A letter received in answer to a follow-up letter stated that she died after a five day illness on June 16, 1935 (nine years after the first operation). Until then she had seemed to be in rather good health.

The remaining 7 patients received roentgen-ray therapy postoperatively. Data concerning them appear in Table 1. The general plan of these treatments was the same for all. The pelvis was divided into four fields, with upper abdominal fields when indicated by the presence of a mass, and each area received about 540 r, measured in air. The factors used were 200 kv., 0.75 mm. copper filtration plus 1 mm. aluminum filtration and 50 cm. target-to-skin distance.

Comment on Cases. One of these patients received additional roentgen-ray therapy in her home town. Four patients returned three months after their first treatment for a second series, and 2 received three series of treatments at three month intervals. The treatment and total dosage in each instance were about the same as those given above.

A follow-up study of these patients showed that 6 were living and had no evidence of disease after fifteen, thirteen, eleven, ten, nine and one year, respectively. One patient died after three and a half years, of what was thought to be metastasis to the liver.

RADIATION THERAPY

To evaluate the radiosensitiveness of granulosa-cell tumors, both as it is reported in the literature and as it appears from the study of our own cases, a short discussion of dosage may be in order.

For data on the doses administered to our patients who were treated with radium alone, Figure 1 may be consulted. This chart, prepared by Williams, shows the shape of the isodose curves of a 50 mg. tube of radium filtered through 1.5 mm. of monel metal. The curves show that the ovaries cannot be irradiated uniformly from a radium source located in the uterus. To obtain a maximal dose in the area treated, this area must be situated at the center of the tube, because as either end of the tube is approached, the percentage of the dose at the same distance decreases. Also, a change of distance from 4 cm. to 6 cm. from the center of the source decreases the dose from 50 to 22 per cent of the dose at the source. The curves also show that the part of the ovary nearest the radium source (which as a rule is in the uterus) may receive many times the quantity of irradia-

* Previously reported by Hodgson, Dockerty and Mussey.

tion received by other, more distant parts of the ovary. [Reference to this chart also shows the great decrease in dose which may be possible when the ovary is greatly enlarged, as it is in many cases of granulosa-cell tumor. Furthermore, variations in thickness, contour, or consistency of the uterine wall may introduce the varying factor of decreased absorption, a value not considered in these curves. Many other variations of dosage might be pointed out, but we believe these considerations are sufficient to bear out the statement that complete radium treatment of granulosa-cell tumors from with the uterus is impossible.]

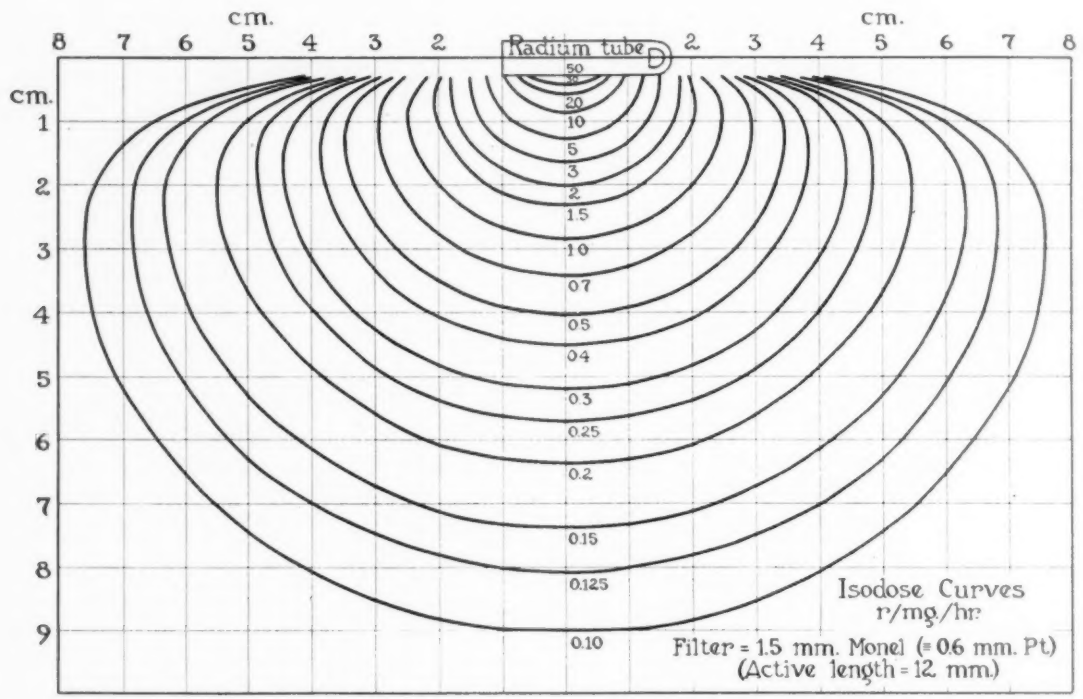

FIG. 1. Isodose curves of a 50 mg. tube of radium filtered through 1.5 mm. of monel metal. These curves would seem to indicate that the ovaries cannot be irradiated uniformly from a radium source located in the uterus. Chart was prepared by Dr. M. M. D. Williams, Division of Physics and Biophysical Research, Mayo Clinic.

Second, we should like to point out that the low or "menopausal" doses of irradiation which have been administered by many therapeutic radiologists and which have resulted in cessation of symptoms have led them to believe that granulosa-cell tumor is very radiosensitive. Actually, in many cases, subsequent examination has revealed a return of symptoms and even an increase in the size of the tumor. These facts, therefore, lead us to believe that the secretory property of the granulosa cells (which are very radiosensitive) is destroyed by such doses, as it is in the normal ovary, and that perhaps the symptoms abate because of this lessening of the secretion of estrin. However, the neoplastic tendency of the cells is not destroyed. Since the lesion in point is, of course, a cancer rather than a normal ovary, new cells are soon formed from more or less intact cells, and perhaps the symptoms return because of the estrin secreted by these new cells. To destroy or completely to inactivate a granulosa-cell tumor, therefore, it would seem necessary not only to administer enough radiation to prevent the secretion of estrin, but also to prevent growth of the tumor which is promoting the formation of new secretory

cells. This, we believe, cannot be accomplished by the introduction of radium into the uterus. For the reasons stated, this tumor should be classed in Desjardins' group three, with lesions which are moderately radiosensitive. Most other adenocarcinomas of the ovary are more or less resistant.

It is on the basis of this line of thought that the technique used to irradiate granulosa-cell tumors at the Mayo Clinic has been evolved. The roentgen rays are generated at 200 kv., are filtered through 0.75 mm. of copper and 1 mm. of aluminum, the distance is 50 cm., and a surface dose of about 540 r per field is given to each of two anterior and two posterior pelvic fields. When the patients are large and weigh 160 pounds (73 kg.) or more, two lateral fields, are added, as a rule, or the surface dose may be increased.

In cases in which the tumor ruptured before it could be removed, the roentgen-ray treatment is administered to the entire abdomen through four anterior fields—one to each of the four abdominal quadrants—and through four corresponding posterior fields in order to prevent extension of the lesion to the upper part of the abdomen. This method is used because it seems to cause less injury to the blood and is less disturbing to the intestinal tract, provided that the treatment is not administered too rapidly.*

The patient should return in from two to three months for examination and probably for another course of treatment. She should return again when her general condition indicates that more treatment is advisable, or at least once in six months.

Such periodic examination is advisable so that early signs of new growth can be detected, and so that treatment can be instituted immediately if it is indicated.

SUMMARY

Eleven of fifty cases of granulosa-cell tumor of the ovary have been reviewed or mentioned. In the eleven cases in question the patients received radiation therapy. These tumors probably arise from embryonic mesenchyme. Anatomically and functionally, the tumor-cell unit resembles the granulosa cell. Folliculoid, cylindroid and diffuse patterns probably represent varying degrees of differentiation rather than separate entities.

A pathologic report of "late proliferative endometrium" from a patient who has intermittent, periodic postmenopausal bleeding should demand exploratory laparotomy, even in the absence of a palpable pelvic tumor. Recurrence of bleeding after a so-called menopausal dose of roentgen rays in an elderly woman should lead the physician to suspect granulosa-cell tumor. On the basis of the low grade of malignancy of the tumors in question conservative surgical treatment seems to be indicated for women in the reproductive period of life who desire children. Single erythema doses of radiation only depress the physiologic function of the cell to secrete estrin and are not enough to destroy the neoplastic tendency of granulosa-cell tumors. This tumor should be treated as are other forms of ovarian cancer.

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* We have had no experience with techniques which employ higher doses.

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Vol. 59, No. 5

COMPARISON OF INTRADERMAL AND OCULAR METHODS OF TESTING FOR SENSITIVITY TO DIODRAST*

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THE use of contrast media in roentgenography has greatly enhanced its value as a diagnostic procedure in the study of the various systems of the body. Since its introduction, intravenous urography has become a valuable and frequently used method of study. Any purely diagnostic study should subject the patient to the least possible risk. Where risk exists inherently, every means of avoiding or minimizing it should be used.

Intravenous urography entails an inherent risk. Fortunately it is statistically very small. In 1942 Pendergrass and his associates[4] published the results of a survey covering approximately 662,000 examinations in which contrast media were used. They included data on 26 unreported cases of death occurring after the use of contrast media, although only 10 of these were considered by the authors to have resulted directly from hypersensitivity to the injected material. Diodrast had been used in all 10 cases, and in none of them had there been any tests for sensitivity performed. Severe, non-fatal reactions were also reported during the survey. These followed the use of a variety of contrast media.

The avoidance of reactions is worth while both with regard to the patient's welfare and for the physician's peace of mind. Proper precautions are also highly desirable for protection in any medicolegal consequences. At least one suit for damages has followed a death occurring subsequent to the use of a contrast medium.[4]

Various methods of testing for sensitivity to diodrast have been reported. Naterman and Robins[3] have recorded their experience with the intradermal test in 404 cases. In a later publication Robins[5] added 240 additional cases tested by the same means. Archer and Harris[1] failed to find satisfaction with several methods of testing, including the intradermal method. They began using the conjunctival test and have recorded their observations in over 600 cases. As soon as they had gained confidence in the ocular method, they discontinued the simultaneous use of the intradermal test because of their feeling that the conjunctival method was superior.

The present communication reports on the simultaneous use of the intradermal and the ocular methods of testing in 160 cases. Observations concerning the relation of an allergic background with positive skin tests and also with general reactions to intravenous injection of diodrast are recorded. The effect of previous urography with regard to production of sensitivity to diodrast is discussed.

METHOD OF STUDY

A detailed history was obtained from each patient prior to urography. A form similar to that used by Pendergrass and his associates[4] was followed. This included any personal history or family history of allergy, a record of previous intravenous urography and any reactions therefrom, results of present intradermal and ocular tests and a tabulation of reactions to the present injection of diodrast. A conjunctival test using undiluted diodrast was performed as outlined by Archer and Harris.[1] Following the directions of Naterman and Robins,[3] an intradermal test with 0.05 cc. of undiluted diodrast was done on one forearm, and a control was done on the other forearm. Sterile water was used for the control instead of saline, which was used by Nater-

* From the Department of Radiology of the Lankenau Hospital, Philadelphia, Pennsylvania.

man and Robins. According to the manufacturer* diodrast is dissolved in sterile water. This slight change is felt to be of some importance in the reading of the tests as distilled water injected intradermally frequently causes a larger area of erythema than does diodrast. The injection of distilled water, however, does not appear to cause an increase in the size of the wheal or to produce protrusions.

In reading the intradermal tests the criteria of Naterman and Robins were used with careful comparison of the test and control sites. The total of positive intradermal tests was reduced by the number of cases in which the control erythema exceeded the erythema caused by diodrast. The ocular tests were read according to the directions of Archer and Harris. One is impressed by the marked difference in the frequency of positive reactions obtained by the two methods of testing. The ocular test caused changes in the conjunctival vessels of only 6 patients. In each instance the changes were minimal. Archer[2] states that even mild positives occur in only 2 per cent of individuals tested. Positive skin tests were observed 43 times. The degree of positivity varied, but the majority showed only mild changes. There were a few moderately positive skin tests but no strong positives.

Reactions to the intravenous injection of diodrast, even very slight ones, were recorded as observed, and classified as allergic, neurovascular, or mixed. Urticaria, edema, asthma, rhinorrhea, and sneezing were considered allergic symptoms. Neurovascular reactions included flushing, nausea, vomiting, syncope, pallor, a sense of constriction, shoulder pain, and circulatory disturbances. Mixed reactions were characterized by the simultaneous occurrence of symptoms from each group. A tabulation of individual symptoms showed that certain ones were observed most frequently and in the following order numerically: nausea, flushing, sneezing, urticaria, and vomiting. This last seems to be more likely if the injection is made rapidly. Frequently several symptoms were observed at the same time. The number of patients with neurovascular reactions exceeded the combined total of those with mixed and those with allergic reactions. There were more mixed reactions than allergic.

* Winthrop Chemical Co., Inc.

RESULTS OF TESTS

In 160 cases general reactions after the intravenous injection of diodrast were observed 61 times. The great majority of these were not alarming. In 5 instances the degree of reaction was moderate. Four displayed symptomatology predominantly neurovascular. The fifth moderate reaction caused extensive urticaria and an acute exacerabtion of renal colic. No severe reactions such as those mentioned in other reports[1,3] were observed.

In these 5 instances of moderate reaction the ocular test was slightly positive twice. The other 3 were entirely negative. The intradermal test showed 1 mildly and 1 moderately positive reaction in the 5 cases, and these positives were observed in conjunction with negative conjunctival results. One patient of the 5 showed no reaction to either test, but she had a marked urticaria. The combination of the tests showed no correlated trend from which to predict the reactions which occurred.

On 4 other occasions the ocular test was slightly positive. In 2 instances there were mild general reactions but in the other 2 no reactions were observed. There were therefore 4 reactions in 6 patients having mildly positive ocular tests.

The intradermal tests proved less useful as a means of predicting general reactions. It was positive in only one-third of the cases in which reactions were observed. In those cases where there was no reaction to the intravenous injection of diodrast the intradermal test was positive approximately 1 time in 4. As stated previously very few skin tests showed more than a mildly positive reaction and there was no particular correlation between these and the occurrence of moderate generalized reactions.

EFFECTS OF PREVIOUS UROGRAPHY

Careful consideration was given to this because of the question concerning the

production of sensitization by intravenous injections of diodrast. Among the 160 patients studied 29 had had previous intravenous urographic studies. The exact nature of the contrast medium could not always be determined but it is reasonably sure that diodrast had been used in the majority. Of these 29 individuals, 21 reported a single previous intravenous urography. Four patients had been examined twice by this method and there were 2 patients whose records showed three previous intravenous injections of contrast material. Two individuals had experienced intravenous urography on four occasions. Thus in 29 patients there had been forty-three previous urograms. No severe reactions were recalled by them, although some minor sequelae were remembered. Neither the incidence of general reactions nor their severity was greater for patients who had undergone previous intravenous urography than was true for the group being examined for the first time. Robins reported similar observations. It is interesting that all 5 of the moderate general reactions were observed in patients who had never had a previous intravenous urogram. Although the number of patients who had received two, three or four previous intravenous injections were not sufficiently great to furnish an adequate statistical sample, there was no indication of any increasing frequency of reaction with the consecutive examinations.

Previous intravenous urography did not appear to affect the probability of a positive intradermal test. In this group the incidence of positive skin tests did not differ significantly from the incidence recorded in the group with no history of previous intravenous urography. Three patients were examined twice during the course of this study, and it was possible to compare the ocular and intradermal tests done before each urogram. In none of these cases was there any significant change in the degree of reaction shown by either the skin or the conjunctiva. No conclusion is attempted regarding the effect of previous urography upon the conjunctival reaction because of the low incidence of positive conjunctival tests. Of the 6 patients who had positive conjunctival tests in this series there were 2 who had previously undergone intravenous urography.

VALUE OF A HISTORY OF ALLERGY

The data obtained in this series did not show a correlation between a history of allergy, personal or familial, and a positive intradermal test. On the contrary, negative skin tests occurred in association with such a history more frequently than did positive skin tests. No explanation of this is apparent. General reactions after intravenous injection occurred approximately one and a half times more frequently when there was a personal or familial history of allergy. The 5 moderately severe reactions observed, however, had no more pronounced background of allergy in the individual or family than did the reactions of mild degree. Apparently the allergic background does not predispose the individual to a positive conjunctival reaction to diodrast. There was no correlation between such a history and a positive result on the ocular test.

COMMENT

The object of this and other investigations is the establishment of a rapid and accurate method of testing for sensitivity to diodrast. The ocular test requires very little time and the procedure is exceedingly simple. The intradermal test necessitates the use of sterile syringes and solutions, and the time needed for testing is longer (ten to fifteen minutes). Practically the ocular test is superior with regard to ease of performance and interpretation.

In judging the comparative reliabilities of the two methods one must give attention to the extensive studies which have been reported. Naterman and Robins[3] found fairly close agreement between the results of intradermal tests and generalized reactions. Approximately three-fourths of patients without generalized reactions had negative skin tests, while the remaining one-fourth had positive intradermal tests. Of

these individuals who did have generalized reactions to intravenous diodrast, over 80 per cent had positive intradermal tests. Although there were definite exceptions, these authors, found that in general the more serious generalized reactions occurred in conjunction with the more strongly positive cutaneous tests. They felt that a strongly positive skin test should warn one to expect a serious reaction following intravenous injection. In a later report Robins[5] stated that although skin tests do not permit a definite conclusion as to the development of systemic reactions or their severity when they do occur, in some cases at least untoward reactions can be foretold.

Archer and Harris[1] concluded that the conjunctival test was very accurate and more reliable than any other test which they had used. In the presence of a moderate or marked conjunctival reaction to diodrast, a moderate or severe generalized reaction uniformly followed an intravenous injection. In several cases where the intradermal test was negative but the ocular test positive severe generalized reactions occurred when the diodrast was given intravenously.

In this study there were no strongly positive cutaneous tests, and only minimal changes were seen in the small group with positive ocular tests. No severe general reactions occurred. The data did not seem to indicate that either mild or moderate generalized reactions could be predicted by the use of the cutaneous or ocular tests singly or in conjunction with each other. In the small number of cases showing moderate generalized reactions, there was no correlation of the results of the two methods. One fact may be emphasized: no severe generalized reaction occurred in 160 cases in which there was no instance of a moderately or strongly positive conjunctival test. Also, no strongly positive intradermal test was observed in this series.

A combination of the conclusions reached by others with those developed during this study seems to indicate that the ocular test is more easily performed than the intradermal and is more reliable in indicating dangerous sequelae. Apparently a negative cutaneous test does not exclude the possibility of a severe, generalized reaction, but such an outcome has not been recorded when the conjunctival test was negative. A strongly positive reaction to either test, however, should be regarded as a definite warning of possible serious consequences from an intravenous injection.

CONCLUSIONS

1. It is desirable to determine the sensitivity of individuals to diodrast before proceeding with its injection intravenously.
2. The conjunctival test can be done easily and quickly. It is a reliable guide in avoiding severe generalized reactions.
3. The intradermal test is slower and does not appear to exclude entirely the possibility of such reactions.
4. Positive intradermal tests are no more frequent when there is a personal or familial history of allergy, nor does such a history appear to affect the conjunctival reaction.
5. In this study mild general reactions were observed one and a half times more frequently in the group with personal or familial histories of allergy.
6. Previous intravenous injection of diodrast does not sensitize the individual to a subsequent injection, nor does it alter the probability of a positive reaction to the intradermal test.

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Vol. 59, No. 5

ROENTGEN-RAY CALIBRATION OF PHOTOGRAPHIC FILM EXPOSURE METER

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I. INTRODUCTION

SINCE the earliest use of roentgen rays, photographic films carried about on a person have been used to detect stray radiation. These have found important application in the control of safety conditions around atomic piles. It was soon realized that the early techniques were neither sufficiently controlled nor accurate. As a result, in early 1944 a more accurate type of film meter was developed on the Atomic Energy Project. Basic work by Pardue and others[1] resulted in the development of film meters for monitoring radiations of different types and over wide potential ranges. Various types of emulsions and filter materials were investigated, resulting in the use of a meter of the type employed in these studies.

It was proposed by Parker that two films be packaged in the same envelopes, one film to be as sensitive to gamma radiation as possible, and the other to be relatively insensitive. In the event of over-exposure sufficient to blacken completely the sensitive film (about 5 r) a check reading up to some 30 to 40 roentgens would be available. The now standard du Pont packet type 552 resulted from this proposal.

In this meter a packet of two du Pont number 552 dental roentgen-ray films without lead backing are contained in the same package, but having respectively sensitive and insensitive emulsions, and are placed in a light, metal container to be worn by the person. Approximately one-half of the film packet is exposed directly, without any filter material other than the containing wrapping. The other half is shielded on both sides by 1 mm. of cadmium. The portion of the film exposed without filter will be referred to as the "open window" reading and is used primarily to pick up very soft radiations, including beta rays. The other half of the film, filtered by the cadmium, is referred to as the "shield" reading. Its purpose is to detect gamma rays, where the cadmium is interposed to minimize the wavelength dependence of the film emulsion response. In the early work, both portions of the film were tested over a limited energy range to determine the wavelength dependence of each emulsion response and the optimum thickness of the cadmium shield.* It was felt desirable, however, to extend these measurements over a much wider energy range, and, at the same time, provide accurate measurements of exposure. We have, accordingly, exposed a series of films to calibrated beams of radiation over the range of 10 to 1,400 kv., with filtration increasing as the potential is raised. Film densities were then obtained by means of an Ansco-Sweet densitometer and the relation between exposure and film blackening determined.

II. EXPERIMENTAL EQUIPMENT AND PROCEDURE

The film meters were exposed to roentgen-ray beams produced by constant potentials. In the range from 10 to 200 kv. the roentgen-ray tube was of the oil-cooled type, having a beryllium window 1.5 mm. thick. For the 250 kv. point a standard shockproof tube having heavy glass walls was employed. For measure-

[1] Pardue, L. A., Goldstein, N., and Wollan, E. O., Ch-1553, April 8, 1944.

* In early experiments lead and silver were also used as filter. It was found that cadmium would be a reasonable substitute for the preferred metal, silver.

TABLE I

Voltage (kv.)	Filtration	Dosage Rate (r/min.)	
		0.1 r Exposure	0.5 r and 0.1 r Exposures
10	minimum*	0.30	1.32
15	minimum*	0.84	0.84
20	minimum*	1.00	1.00
25	0.5 mm. Al	0.31	2.11
30	0.5 mm. Al	0.31	3.28
35	0.5 mm. Al	0.26	3.21
40	0.5 mm. Al	0.31	3.52
45	0.5 mm. Al	0.37	4.26
50	0.5 mm. Al	0.40	3.80
60	1.0 mm. Al	0.24	3.97
70	1.0 mm. Al	0.34	3.64
80	2.0 mm. Al	0.26	2.81
90	3.0 mm. Al	0.24	3.04
100	0.2 mm. Al	0.36	2.90
110	0.2 mm. Cu	0.39	3.56
120	0.3 mm. Cu	0.42	3.44
130	0.3 mm. Cu	0.44	3.46
140	0.5 mm. Cu	0.49	3.20
150	0.5 mm. Cu	0.47	3.02
160	1.0 mm. Cu	0.70	3.37
170	1.0 mm. Cu	0.60	2.81
180	1.5 mm. Cu	0.41	3.00
190	1.5 mm. Cu	0.49	3.33
200	2.0 mm. Cu	0.51	3.12
250	6.18 mm. Cu	0.84	0.84
500	minimum**	0.026	0.066
600	$\frac{1}{16}$ in. Pb+$\frac{1}{4}$ in. Fe	0.080	0.080
700	$\frac{1}{8}$ in. Pb+$\frac{1}{4}$ in. Fe	0.070	0.070
800	$\frac{1}{4}$ in. Pb+$\frac{1}{4}$ in. Fe	0.015	0.075
900	$\frac{1}{2}$ in. Pb+$\frac{1}{4}$ in. Fe	0.0087	0.044
1000	$\frac{3}{4}$ in. Pb+$\frac{1}{4}$ in. Fe	0.019	0.091
1200	$\frac{3}{4}$ in. Pb+$\frac{1}{4}$ in. Fe	0.022	0.056 for 0.5 r 0.113 for 1.0 r
1400	$\frac{3}{4}$ in. Pb+$\frac{1}{4}$ in. Fe	0.028	0.069 for 0.5 r 0.138 for 1.0 r

* Minimum filter refers to 1.5 mm. of beryllium.
** Inherent filtration of million volt roentgen-ray tube is 1.0 mm. of tungsten plus $\frac{1}{4}$ inch of copper plus $\frac{1}{2}$ inch of water.

ments over the range of 500 to 1,400 kv. National Bureau of Standards' high voltage tube having a 1 mm. tungsten transmission target was used, with the roentgen-ray beam taken off on the axis of the electron stream. The roentgen-ray beams were calibrated in roentgens by means of a free-air ionization chamber up to 200 kv. Above this, the measurements were made with a Victoreen 0.25-r condenser r-meter which had itself been calibrated up to 200 kv. against the standard ionization chamber. No additional shield was placed over the r-meter in the high energy range, since previous experience had indicated that up to 1,400 kv. this chamber probably operates under suitable electronic equilibrium conditions.

The radiation output was held constant while both the ionization chambers and the films were exposed. The actual conditions of exposure are listed in Table 1. At each voltage the films were given exposures of 0.1, 0.5, and 1.0 r. The rates for the 0.5

and 1.0 r exposures were usually the same, the quantity being controlled by varying the time. The 0.1 r exposures were always carried out at a lower rate, usually about one-tenth of that used for the larger quantities.

Fifteen films were exposed for each roentgen-ray tube potential and each quantity of radiation. Five of each fifteen were retained and processed by the National Bureau of Standards. The remainder were developed at Clinton Laboratories in two separate runs using du Pont Liquid X-ray Developer for three minutes at 20° C. There was no consistent or significant difference between these sets developed at different times and places.

In addition to the exposures made with roentgen rays, five other films were given exposures of 0.1, 0.5, and 1.0 r in the Clinton Laboratory's standard radium calibration rack. These films were developed with those of the second run and densities measured in the same manner as for all other films. The radium calibration points are plotted on the respective curves at an arbitrary position on the potential scale.

III. EXPERIMENTAL RESULTS

The final results of these measurements are shown in Figures 1 to 4. The film density, as measured on the Sweet densitometer, is plotted against the roentgen-ray tube potential expressed in kilovolts. It should be pointed out that the quality of the roentgen-ray beam is somewhat arbitrary because widely different filters were used. However, the curves are very flat in the high potential region. Therefore, little significance seems to be attached to the uncertainty in the hardness of the radiation. Figure 1 shows the density-potential dependence of the shield readings for the sensitive film. Figure 2 shows the corresponding dependence for the sensitive film with the open window. Figure 3 shows the insensitive film open-window readings, and Figure 4 shows the insensitive film shield readings.

It is noted that exposures made with the same filters but with increasing voltage tend to group together and deviate from the smooth curve. This is noted, for example, in Figure 2, where the first three points on the 0.1 r curve were obtained at 10, 15, and 20 kv. and no filter respectively. These indicate a less rapid increase of the density with increasing voltage than is indicated by the smooth curve through all experimental points. There is a similar deviation for the next six points on the same curve, obtained at higher voltages and with a different filter. The explanation for this is that the emulsion response increases with hardness of roentgen rays up to 90 kv., together with the fact that filtration removes roentgen rays of short wavelength predominantly.

The results of all of the measurements were reasonably consistent, the majority of the readings showing a variation of less than ± 0.03 unit. Deviations larger than this are indicated on the curves. It will be noted that in a very few instances the average deviations are very large, but this may be ascribed to either an accident in the processing, or possibly to mixing of a film number.

IV. CONCLUSIONS

The response of the open-window and shield readings for both sensitive and insensitive films appears to be independent of the radiation potential above 400 kv. It is further noted that the radium calibration points inserted on each set of curves show fairly good agreement with the readings of the film meter when exposed to roentgen rays in the high-potential region. The agreement is not perfect, but it can be considered as satisfactory for most practical purposes.

Between 150 and 300 kv. the shield readings show densities substantially higher than those obtained for the higher potential exposures. The maxima, which occur at about 200kv., are roughly 30 per cent higher than the values in the high-potential range. This is in error by 30 per cent in the low-potential as compared with the high-poten-

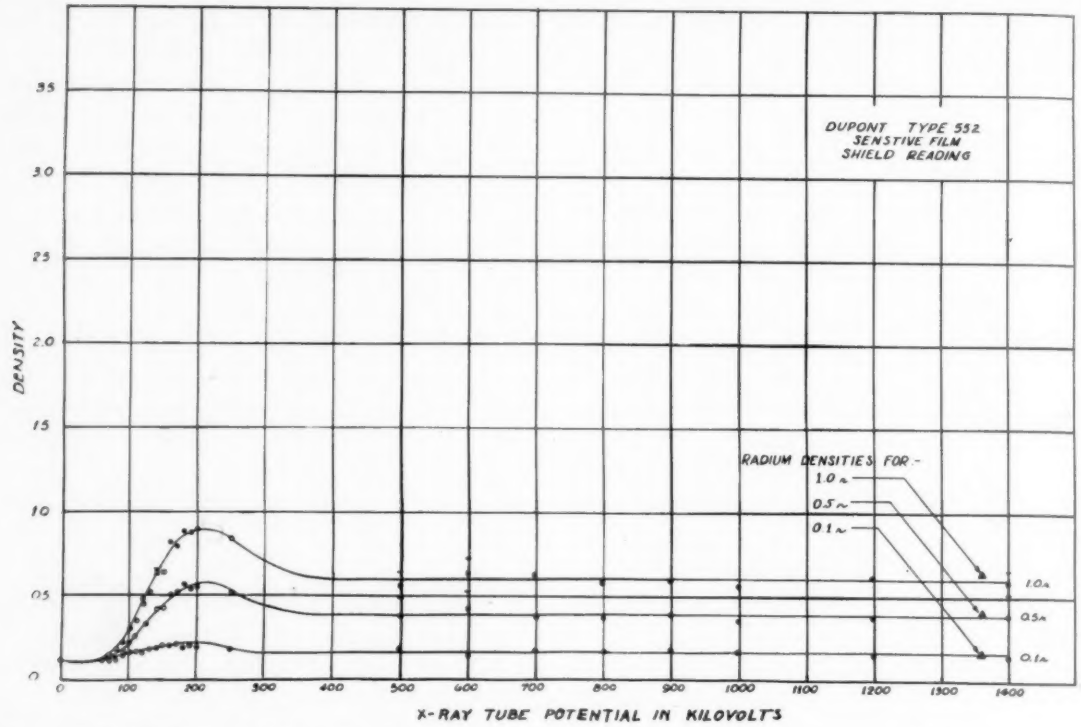

FIG. 1. Densities of films with sensitive emulsion contained in du Pont packet type 552 which were exposed between 1.0 mm. cadmium shields of film exposure meter to roentgen-ray quantities of 0.1, 0.5, and 1.0 r respectively, produced by potentials over the range of 10 to 1,400 kv.

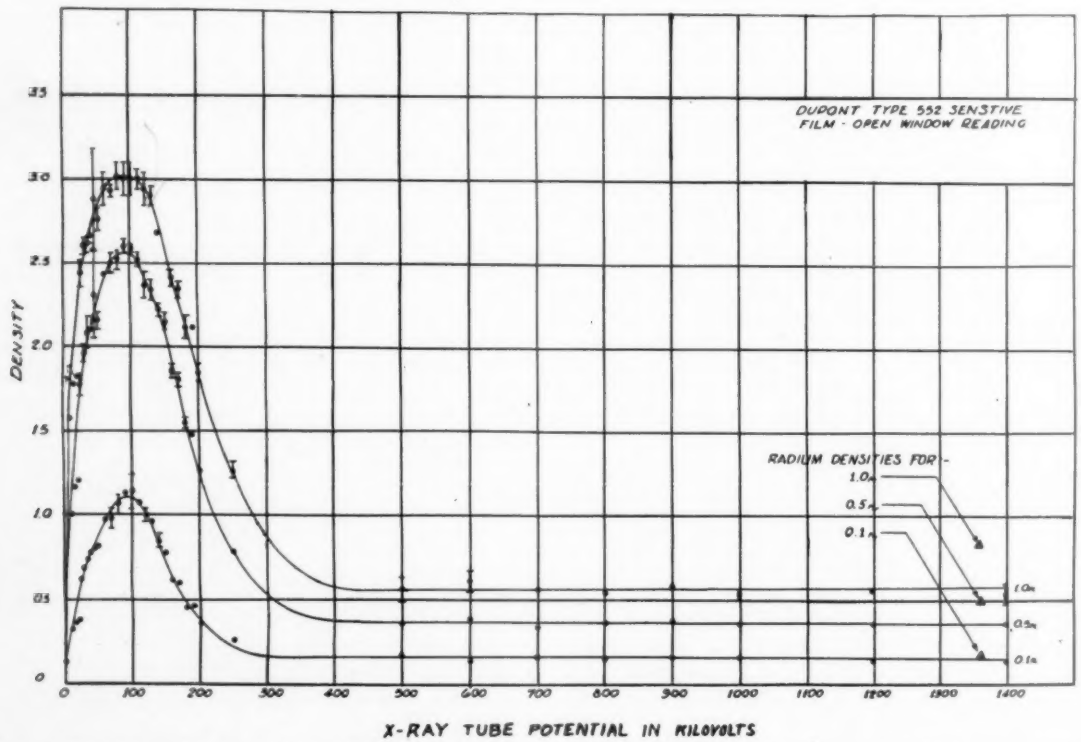

FIG. 2. Densities of films with sensitive emulsion contained in du Pont packet type 552 which were exposed in the open-window portion of film exposure meter to roentgen-ray quantities of 0.1, 0.5, and 1.0 r respectively, produced by potentials over the range of 10 to 1,400 kv.

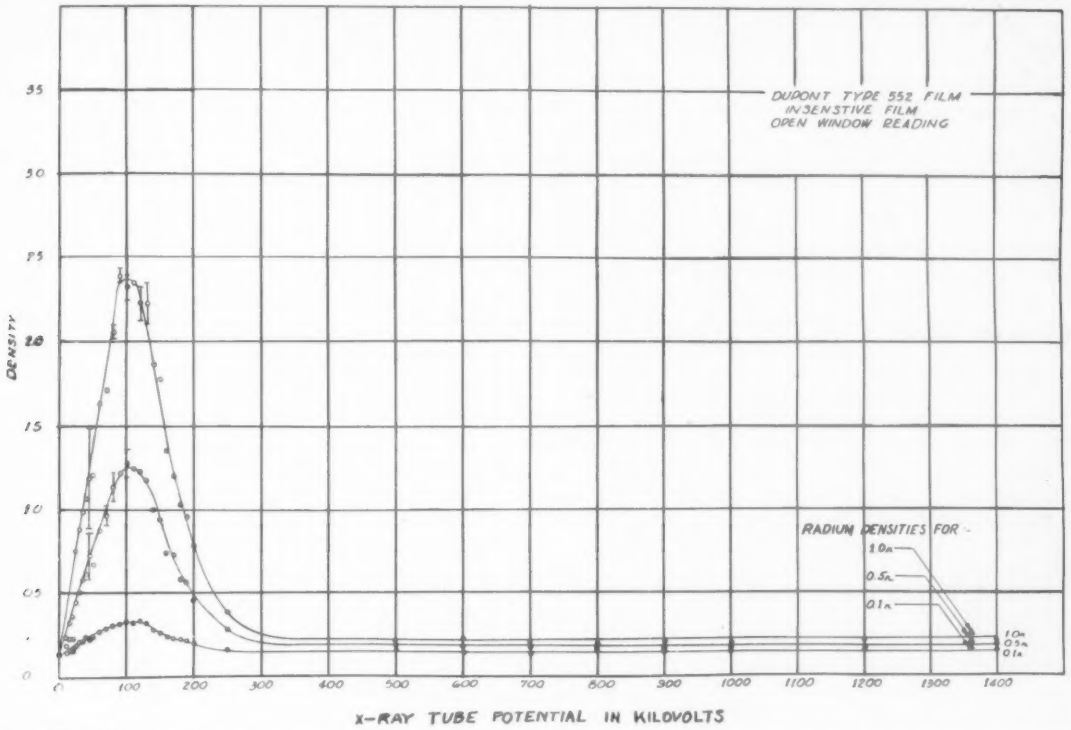

FIG. 3. Densities of films with insensitive emulsion contained in du Pont packet type 552 which were exposed in the open-window portion of film exposure meter to roentgen-ray quantities of 0.1, 0.5, and 1.0 r respectively, produced by potentials over the range of 10 to 1,400 kv.

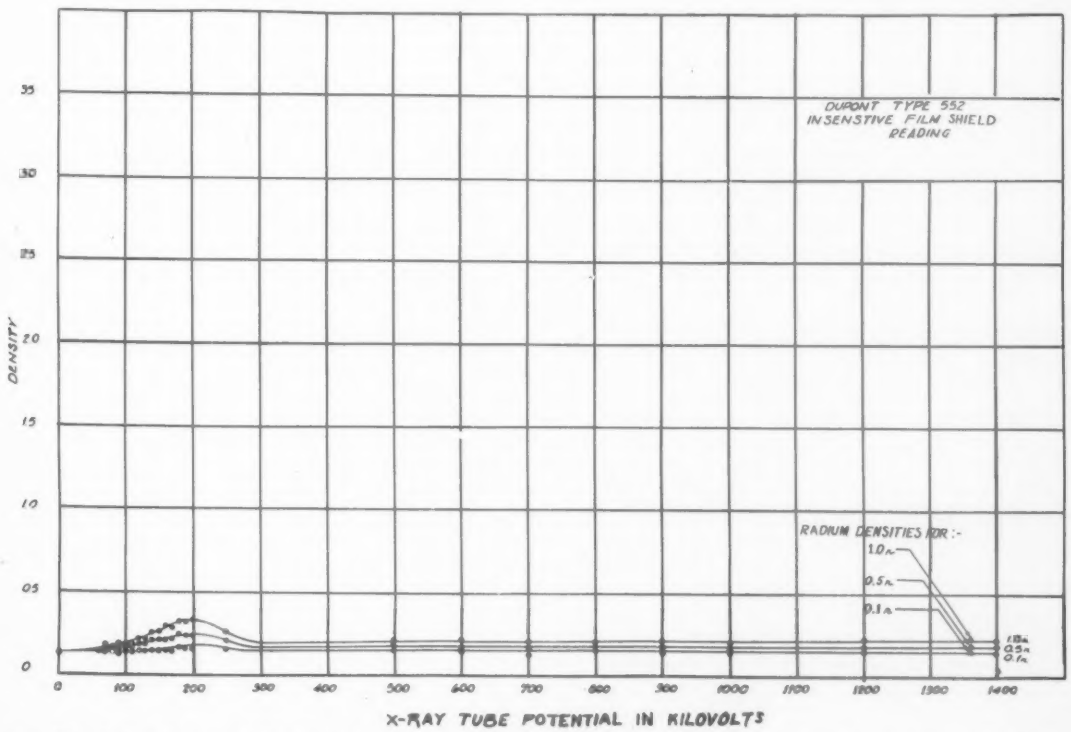

FIG. 4. Densities of films with insensitive emulsion contained in du Pont packet type 552 which were exposed between 1.0 mm. cadmium shields of film exposure meter to roentgen-ray quantities of 0.1, 0.5, and 1.0 r respectively, produced by potentials over the range of 10 to 1,400 kv.

tial region. The apparent danger to personnel is greater than the actual, therefore, in situations where there are substantial soft components to the exposure. The shield readings with the insensitive film are slightly lower below 150 kv. than above 400 kv. However, the differences are so small that they may be neglected. This is not true for the shield readings of the sensitive film in the low-potential region, where the densities fall off sharply.

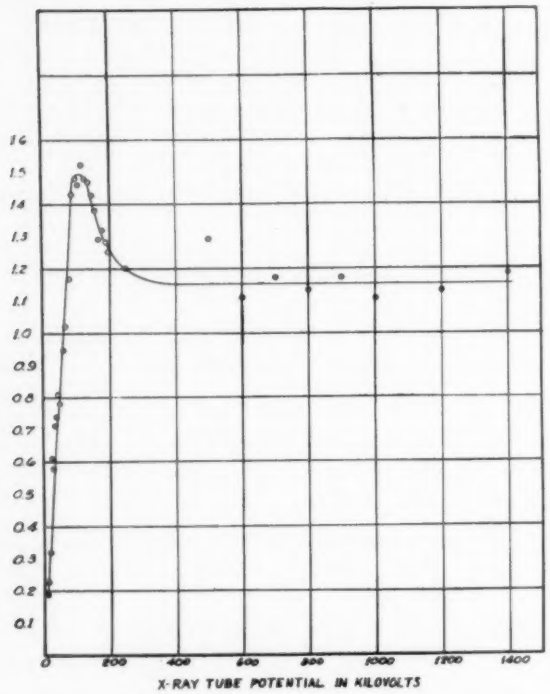

FIG. 5. Ratio of Victoreen pocket chamber readings obtained during roentgen-ray exposure to their readings during exposure to an equal quantity of radium gamma rays.

The open-window curves show maxima of density at about 90 kv. In these cases the maxima are approximately 600 per cent higher than the densities in the potential region above 400 kv. Considerable care must be exercised in ascertaining the portion of the potential region to which the film was exposed if this type of reading alone is used to determine exposure. This applies particularly in the roentgen-ray region up to 200 kv. and becomes less important in the gamma-ray region.

V. ADDENDUM

While the measurements described above were being carried out, it was convenient at the same time to determine the potential dependence of the Victoreen pocket-type ionization chamber. Accordingly, four pocket-type chambers were inserted into the beam for each condition of potential and filtration and an average of their readings determined for each condition. Up to 200 kv. the potential dependence was determined in terms of the free-air ionization chamber, and from 250 kv. up, the dependence was in terms of a Victoreen 0.25 r condenser r-meter.

Those data are plotted in Figure 5 as the ratio of Victoreen pocket chamber readings obtained during roentgen-ray exposure to their readings during exposure to an equal quantity of radium gamma rays. It will be observed that the pocket chamber readings show a variation of 1,500 per cent in the region up to 200 kv., where the comparison was made with a standard ionization chamber. This ratio reaches a maximum at about 125 kv. and then starts to fall off rapidly towards a steady value which is reached at about 300 kv. At the high voltages, the readings from exposure to roentgen rays at the National Bureau of Standards are about 15 per cent higher than those obtained during calibration by exposure to radium gamma rays at the Clinton Laboratories. The cause of this discrepancy has not been established but will be the subject of early investigation.

F. H. Day
X-Ray Section
National Bureau of Standards
Washington, D. C.

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EDITORIAL

AFFECTIONS OF THE RESPIRATORY TRACT IN INDIVIDUALS EXPOSED TO COTTON DUST

AMONG the interesting bulletins issued from time to time by the United States Public Health Service is one which has recently appeared entitled "A Review of the Literature Relating to Affections of the Respiratory Tract in Individuals Exposed to Cotton Dust."[1] It has long been recognized that abnormal conditions of the respiratory tract occur among cotton operatives to a greater extent than among the general population, and it is recognized to a greater or lesser extent that the mechanism of the production of these conditions which have been attributed to the inhalation of cotton dust is an industrial hygiene problem of considerable importance and that no acceptable solution of the problem has yet been found, despite numerous surveys and some intensive investigations.

The extent of the problem may be appreciated when it is known that there are more than five million people employed over the world in the cotton textile industry and that approximately 400,000 to 500,000 of these are located in the United States. The literature dealing with investigations of the health of textile workers has been published over many years and in many languages "so that individuals seeking to consult the work of others in the same field sometimes complain that there is little in the literature."[2] However, Caminita, Baum Neal and Schneiter were able to collect some 267 articles written by observers mostly in European countries, including Russia, and to a lesser extent reports from North and South America. Caminita and his associates have discussed the whole question of cotton processing from its harvesting through the processes of ginning, baling, classing and grading, carding, combing, spinning and weaving.

In their report they also discuss the health hazards of cotton textile manufacture, including accidents caused by moving machinery, exposure to abnormally high temperatures and humidity, and exposure to atmospheres with a high dust content. It is of interest to note that the most complete work in this field of investigation has been done by British investigators; even though Great Britain is not a cotton growing country, it has half a million workers employed in cotton manufacture. In addition to cotton manufacture in the United States, this is a cotton growing country and there are included in the workers in the cotton industries those in the cotton ginning and cotton seed mills, both of which are very dusty occupations. It is of considerable interest to note that in the United States serious dust diseases among cotton workers are practically unknown or at least they are unrecognized or the workers leave the industry before some of the more disabling symptoms incident to textile manufacture develop.

Sufficient evidence has accumulated to show that cotton dust is probably the main cause of respiratory affections among cotton workers and that it may act in a number of ways, namely as a mechanical irritant and as a source of allergens, of

[1] Caminita, B. H., Baum, W. F., Neal, P. A., and Schneiter, R. A review of the literature relating to affections of the respiratory tract in individuals exposed to cotton dust. Public Health Bulletin, No. 297. Federal Security Agency, U. S. Public Health Service, Washington, D. C. 1947, pp. 86.

[2] Lung affections from cotton dust. *Lancet*, Feb. 14, 1948, *1*, 252–253.

[3] Pancoast, H. K., and Pendergrass, E. P. Review of our present knowledge of pneumoconiosis, based upon roentgenologic studies, with notes on the pathology of the condition. Am. J. Roentgenol. & Rad. Therapy, 1925, *14*, 381–423.

histamine, and of the toxic metabolic products of microorganisms. The general consensus is that there is no evidence that the cotton dust "acts as a source of silica, of gossypol, or of pathogenic moulds and bacteria." The report calls attention to the fact that while gossypol, a cotton seed lipoid, is known to be poisonous to animals upon ingestion and that it has been mentioned as a possible harmful constituent of cotton dust, no quantitative analyses of the dust for this constituent have been recorded.

The authors call attention to the fact that there are four separate disease entities associated with the inhalation of cotton dust, namely mill fever, byssinosis, weavers' cough, and an acute illness said to be caused by the bacterial toxin of *Aerobacter cloacae* in workers handling low grade stained cotton.

Mill fever is characterized by "irritation of the upper respiratory tract, cough, chills, fever, and at times nausea and vomiting. The symptoms may arise within a few hours after exposure to cotton dust and clear up rapidly upon removal of the patient from the dusty environment. This type of illness usually affects those unaccustomed to breathing cotton dust. Such a patient may develop a tolerance to the dust after a few days. However, weavers' cough may affect both the old and the new operatives handling mildewed yarn, and examination of the dust has revealed the presence of penicillium, mucor, aspergilli and an unidentified fungus. The symptoms of weavers' cough consist of constriction of the chest, mild but progressive dyspnea, cough and expectoration and aching extremities. This disease may improve within a few hours after the removal of the patient from the source of the dust. If roentgen studies are made of the chest at the height of the attacks, the roentgenograms may reveal similarities in appearance with those seen in bagassosis of sugar cane workers.

True byssinosis, however, develops after long and continuous exposures to cotton dust. This produces symptoms resembling chronic bronchitis, emphysema and sometimes asthma. Usually in these cases the dyspnea is progressive and right heart failure often supervenes. However, no true specific roentgen picture is identified with these symptoms. The chest findings in the roentgenograms may resemble those of emphysema with slight or a mild degree of fibrosis. Byssinosis represents the end result of a chronic process.

In general, it may be stated that "while there appears to be some disagreement among roentgenologists as to the denotation of the terms 'sclerosis,' 'fibrosis,' and 'pneumoconiosis,' " terms which have been variously applied to changes seen in some of the workers in the textile industries, roentgenologists "are unanimous in their opinion that there are no lung conditions among cotton operatives that simulate silicosis."

The diseases caused by cotton dust assume a place of more importance especially when it is appreciated that similar conditions may occur among workers who inhale other vegetable dusts such as those of grain and bagasse in this country. While a considerable amount of work has been done on the effects of mineral dusts on the lungs, particularly its roentgenological aspects, it might be well, in view of the report of Caminita and his associates, and the recent report of Lemone, Scott, Moore and Koven[4,5] on "Bagasse Disease of the Lungs" that the roentgenological aspects of the affections of the respiratory tract in individuals exposed to cotton dust be reinvestigated in the hope that out of this study may come a roentgenological picture which is characteristic of these affections.

L. R.

[4] Lemone, D. V., Scott, W. G., Moore, S., and Koven, A. L. Bagasse disease of the lungs. *Radiology*, 1947, *49*, 556–567.

[5] Editorial. Bagasse disease of the lungs. *New England J. Med.*, March 11, 1948, *238*, 378.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14–17, 1948.

American Radium Society
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Stevens Hotel, Chicago, Ill., June 20–22, 1948.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting; San Francisco, Calif., Dec. 5–10, 1948; headquarters, Hotels Fairmont and Mark Hopkins.

American College of Radiology
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Sheraton Hotel, Chicago, Ill., June 20, 1948.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Meets Chicago, Ill., June 21–25, 1948.

Alabama Radiological Society
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Brooklyn Roentgen Ray Society
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Meets January, May, November.

Chicago Roentgen Society
Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Denver Radiological Club
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Secretary, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

Georgia Radiological Society
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Houston X-ray Club
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meetings fourth Monday of each month.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Louisville Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

Michigan Association of Roentgenologists
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio. Next meeting at annual meeting of Ohio State Medical Association, Cincinnati, Ohio, March 31, 1948.

Oklahoma State Radiological Society
Secretary, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual meeting, May 21–22, 1948, Erie, Pa., at Hotel Lawrence.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bimonthly on second Thursday, at place selected by Secretary.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday of January, March, May and October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah Radiological Conference
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

UTAH STATE RADIOLOGICAL SOCIETY
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO
Secretary, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

FACULTY OF RADIOLOGISTS
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGISTS
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD PERUANA DE RADIOLOGIA
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

CONTINENTAL EUROPE

SOCIÉTÉ BELGE DE RADIOLOGIE
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting May 13 and 14, 1948.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland. Annual meeting, on the Bürgenstock, near Lucerne, May 22 and 23, 1948.

COURSES IN TECHNIQUES OF USING RADIOISOTOPES

Announcement is made of a series of three one-month courses to be held at Oak Ridge this summer in the techniques of using radioisotopes. The courses will be conducted by the Oak Ridge Institute of Nuclear Studies.

The courses will be held from June 28 to July 23, August 2 to August 27, and August 30 to September 24, 1948. Application forms and additional information may be obtained from Dr. Ralph T. Overman, Acting Head of the Institute's Department of Special Training, P.O. Box 117, Oak Ridge, Tennessee.

The course will not attempt to cover any special field of application in chemistry or biology but will be based on simple chemical experiments selected and designed to give participants a maximum knowledge and ability in the techniques of handling and carrying on research with radioisotopes. Participants in the second of the three courses will be selected by the Atomic Energy Commission. Personnel of the other courses will be selected from qualified applicants, with preference given to persons connected with organizations which are now engaging in research utilizing radioisotopes, or planning such research. Thirty-two participants will be selected for each course.

A fee of $25.00 will be charged for the course. Participants will be expected to pay their own travel and living expenses. Dormitory or hotel accommodations will be provided in Oak Ridge at the usual rates.

PROGRAM FOR SUPPLYING ISOTOPE-LABELED COMPOUNDS

The increasing demand for compounds containing Carbon 14 has made it desirable to develop a plan under which investigators over the Nation can obtain such substances more readily and at a lower cost than they could if they were forced to synthesize them in small individual lots in their own laboratories. Preparation of relatively large batches would effect a saving in use of equipment and manpower, thus resulting in a reduced cost per millicurie of activity.

In keeping with the policy of the Atomic Energy Commission to encourage private enterprise to participate in developments arising from atomic energy, the Isotopes Division recently invited a number of commercial firms to consider the desirability of engaging in the synthesis and sale of compounds labeled with Carbon 14. Several firms displayed an interest.

To date, the only concern which has completed the formulation of its synthesis program and has received an allocation of Carbon 14 for the purpose is Tracerlab, Inc., 55 Oliver Street, Boston 10, Massachusetts. This company is ready, therefore, to receive orders for certain compounds. Sales will be made to those individuals who obtain authorizations from the Isotopes Division through the usual procedures.

Other firms are considering the feasibility of entering this field. It is hoped that some of these will be ready in the near future to offer for sale other compounds, thus supplementing those which Tracerlab is able to distribute. The possibility of a firm making and selling some compounds which are identical with those offered by another concern is not excluded. The keeping of small supplies of compounds in stock is considered desirable unless it leads to too heavy a drain on the supply of Carbon 14. Wholesome competition will be encouraged, but at the outset the chief concern of the Commission will be to make available a variety of C 14 compounds which will be in demand by a large number of investigators. Emphasis at first will be placed on compounds which can be looked upon as intermediates, suitable as materials from which a large number of other compounds can be prepared.

During the period in which commercial firms are developing their synthesis programs, the commercially available compounds will be supplemented by others prepared in Commission laboratories. These substances will be distributed in limited amounts and whenever a commercial firm is ready to produce a given compound for sale, the Commission will withdraw from distributing this compound.

The list on the following page shows the compounds which are to be made available by Tracerlab in the near future. The tentative production schedule, or availability dates, are shown also.

a. *Barium carbide*—70%—not to be stocked. Available one week after order received.

b. *Acetylene*—HC* = C*H—not to be stocked. Can deliver one week after order received.
c. *Sodium cyanide*—dry solid containing small excess of alkali—available March 26, 1948.
d. Methyl alcohol and methyl iodide—available May 1, 1948.
e. *Carboxyl-labeled acetic acid, acetyl chloride, ethyl acetate*—available May 1, 1948.
f. *Benzene*—low activity, ca 1 mc. 100 mM—available May 1, 1948.
g. *Methylene-labeled ethyl alcohol and ethyl iodide*—available July 1, 1948.
h. *Methyl-labeled acetic acid, acetyl chloride, ethyl acetate*—available August 1–September 1, 1948.
i. Methyl-labeled ethyl alcohol and ethyl iodide—available August 1–September 1, 1948.

Excepting benzene, the specific activity will be of the order of 1 mc per millimole of compound.

Additional compounds will be available from Tracerlab and other firms from time to time. The Isotopes Division and the firms concerned will make appropriate announcement when these compounds are ready for distribution.

The steps involved in obtaining compounds containing C 14, which are for sale by a commercial firm, are as follows:

a. Communicate with the company to determine the availability and price of the compound desired.
b. Send to the Isotopes Division an "Application for Radioisotope Procurement," AEC Form 313, requesting C 14 in the form of the compound desired, and mentioning the name of the firm from which purchase is to be made. *After* review and *approval* of the application, the *Isotopes Division* will return two copies of "Authorization for Radioisotope Procurement," AEC Form 374.
c. Place a purchase order for the allocated C 14 compound with the commercial firm. The original copy of Form 374 must be attached to the purchase order.

Isotopes Division
Oak Ridge, Tenn.

DISTRIBUTION OF CERTAIN RADIOISOTOPES WITHOUT CHARGE FOR USE IN CANCER RESEARCH, DIAGNOSIS AND TREATMENT

We are pleased to announce that the isotopes distribution program in the United States will now include distribution without charge, except for handling and transportation, of certain radioisotopes useful in therapy, diagnosis, and research in cancer. This plan should result in considerable savings in costs of treatment and cancer investigations using radioisotopes.

Effective April 1, 1948, all production charges (list prices) will be removed from the following when the materials will be used for the study of cancer—its nature, diagnosis and treatment:

Isotope	*Catalog Item No.*	*List Price*
Iodine 131	S-2	$1.70 per millicurie
Phosphorus 32	S-3	1.10 pre millicurie
Sodium 24	73	12.00 per irradiated unit

Handling charges to cover the cost of packaging, monitoring, accounting, and billing will be $10 for the first shipment and $10 for each subsequent shipment. Transportation charges will be paid by the applicant.

These radioisotopes may be obtained under present procedures by submitting an "Application for Radioisotope Procurement," Form 313, to the Isotopes Division. The statement of use should be complete in order to justify issuance of "Authorization for Radioisotope Procurement," Form 374, with the provision that your investigation is concerned with cancer research diagnosis or therapy and that no charge will be made for materials.

Other available radioisotopes useful in the study and treatment of cancer may be added to the above list as it is determined that they can be supplied on this new basis. You will be notified of any further additions to this list.

Isotopes Division
Oak Ridge, Tenn.

REVISED PROCEDURE FOR PROCUREMENT OF RADIOISOTOPES

The Isotopes Division of the U. S. Atomic Energy Commission has resently revised the forms required for the procurement of radioisotopes. This was made necessary by the termination on February 29, 1948, of Monsanto Chemical Company's contract with the Government for the operation of Clinton National Laboratory. On March 1, 1948, the Carbide and Carbon Chemicals Corporation assumed operation of this facility (renamed Oak Ridge National Laboratory) for the Commission.

The "Application for Radioisotope Procurement," AEC Form 313, has been revised; the

use of "Supplementary Request for Radioisotope," Form 335, has been discontinued; and an "Acceptance of Terms and Conditions for Order and Receipt of Byproduct Materials (Radioisotopes)" has been prepared to supercede the "Agreement and Conditions for Order and Receipt of Radioactive Materials." Instructions for use are included with each set of forms.

A limited supply of the new forms has been sent to the business office of each firm and institution which has purchased radioisotopes.

If you plan to submit an application for radioisotopes and the new forms are not available at your firm or institution, please write to this office for them.

Isotopes Division
Oak Ridge, Tenn.

LONG ISLAND RADIOLOGICAL SOCIETY

At a recent meeting of the Long Island Radiological Society, the following officers were elected for the ensuing year: President, Dr. Max Dannenberg; Vice-President, Dr. Henry G. Koiransky; Secretary. Dr. Marcus Wiener; Treasurer, Dr. I. Spencer Silverstein.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Pathology of Tumours. By R. A. Willis, D.Sc., M.D., F.R.C.P., Sir William H. Collins Professor of Human and Comparative Pathology, Royal College of Surgeons, London. Formerly Pathologist to the Alfred Hospital, Consultant Pathologist to the Austin Hospital for Chronic Diseases and Lecturer on the Pathology of Tumours in the University of Melbourne, Australia. Cloth. Price, $20.00. Pp. 992 plus 52, with 500 illustrations. London, England: Butterworth & Co. (Publishers), Ltd.; St. Louis, Mo.: C. V. Mosby Co., 1948.

Dr. Rupert A. Willis at the present time is the Sir William H. Collins Professor of Human and Comparative Pathology at the Royal College of Surgeons in London but he is far better known in the United States as the pathologist of the Alfred Hospital, Melbourne, Australia, who wrote a valuable monograph on "The Spread of Tumours in the Human Body." Now he has distilled his twenty years of experience as a pathologist primarily interested in tumors into a single volume of nearly a thousand pages.

This book is written by a pathologist primarily for pathologists, and is constructed along classical lines. The author bases his knowledge on the autopsy and from it erects a massive edifice including precancerous and early lesions. The 500 splendid illustrations are almost all black and white reproductions of photomicrographs very carefully chosen from excellent microscopic preparations which truly fulfill their function of clarifying the text. The 207 introductory pages deal with hypotheses, definitions, names, experimental and animal tumors, the mode of origin, spread and structure of cancer and an interesting critical analysis of statistics. The rest of the book is devoted to a description of regional tumors and certain unusual tumor forms such as the teratomas which receive special attention because of the author's great interest in them. Dr. Willis has read widely, favoring especially British, American and German authors, and to each chapter is appended a carefully selected bibliography with his choice of important papers emphasized in black faced type. Insofar as the problems dealt with concern the pathological anatomy of tumors the reader can rely upon the facts as stated. They are presented clearly, frequently supported by personal cases, conflicts of evidence are noted and the author never leaves the reader in doubt about his own opinions which are unequivocally expressed in vigorous language. This is one of the most appealing features of the book which is redolent of the author's fair-mindedness and honesty of purpose. He says in effect: "Here is the evidence and this is my opinion. Take it or leave it as you will."

One may suspect that the author has not had much personal contact with the clinical features of tumors and lacks familiarity not only with clinical diagnosis but also with the devastating effects of cancers and their treatment upon the victim. Thus the radiologist will find little to help him in his problems of diagnosis and treatment. In the chapters dealing with the stomach and the bones, for instance, the failure to provide any reproductions of the gross features of the various tumors and to correlate them with roentgenograms is a serious omission for one cannot have a well rounded conception of tumors of these tissues or indeed of any part of the body without familiarity with the gross effects of tumor growth. It may be argued that this book is concerned wholly with pathology and has no concern with diagnosis and treatment, but such segregation is impossible nor does the author really adhere to it for occasionally he speaks of radiosensitivity and advocates some form of treatment. These excursions are not always happy as, for instance, when he advocates simple mastectomy as a prophylactic against cancer development for all women with intraductal papillary tumors, a mutilating procedure which cannot be justified by follow-up studies and fortunately for the female population is not carried out by most surgeons. Dr. Willis is not favorably impressed with the value and reliability of the diagnosis of cancer from the examination of secretions or excretions and he has very little to say about it although he has

excellent illustrations of cancer cells in pleural and ascitic fluids. This disregard will disappoint his American public where thousands of washings, smears, sputa and other materials are daily searched for cancer cells.

These criticisms, however, must not blind us to the solid worth of this monograph. Here are gathered together in readable form a formidable collection of basic facts about the pathology of tumors which can serve as a foundation of knowledge upon which the practicing oncologist can build. This book together with Ackerman and del Regato's recent monograph on Cancer, which deals with the subject from the point of view of a pathologist and a radiotherapist working together in a cancer hospital, should together furnish the young oncologist with a firm foundation upon which to support and interpret his own experience with tumors.

ARTHUR PURDY STOUT

EINFÜHRUNG IN DIE RÖNTGENOLOGIE. Ein Lehrbuch für Ärzte und Studierende. By Prof. Dr. med. G. H. Haenisch, Allgemeinen Krankenhaus Barmbeck, Hamburg, and Prof. Dr. med. H. Holthusen, Allgemeinen Krankenhaus, St. Georg, Hamburg. With a section on Physics by the late Prof. Dr. A. Liechti, of Berne, Switzerland. Fourth edition, revised and enlarged, with 378 figures and sketches. Stuttgart: Georg Thieme, 1947.

This new edition of the work by Haenisch and Holthusen comes as a welcome surprise, surprising because it has appeared so soon after the tragic events of the second world war. The composition and presswork are commendable, particularly the reproduction of the roentgenograms. The section on physics and technique by the late Dr. Liechti comprises some forty-two pages of carefully arranged material. The diagnostic section of more than two hundred pages by Haenisch is a most satisfactory text, covering the whole field of roentgenology in a masterly manner. The text is clear; the illustrations are well chosen and, as we have said, especially well reproduced, and manufactured under conditions which must have been exceptionally difficult. The section on therapy by Holthusen, of about one hundred and sixty pages, is also an outstanding example of concise text, excellently arranged, and illustrated.

JAMES T. CASE

APPLIED ANATOMY OF THE HEAD AND NECK: FOR STUDENTS AND PRACTITIONERS OF DENTISTRY. By Harry H. Shapiro, D.M.D., Assistant Professor of Anatomy, College of Physicians and Surgeons, Columbia University. Second edition—revised and reset. Cloth. Price, $10.00. Pp. 303, with 221 illustrations, including 41 in color. Philadelphia: J. B. Lippincott Co., 1947.

In the preface to the first edition, the author emphasizes the importance of a good working knowledge of the anatomy of the head and neck to proper diagnosis and treatment. It was for the purpose of presenting anatomy of the head and neck in a practical manner that he designed the book. This second edition of the book is improved by the addition of new chapters and some extension of the material used in the first edition.

In the first chapter is reviewed the surface anatomy of the face, mouth and neck in relation to surface landmarks and underlying anatomical structures. This is followed by two chapters dealing with the prenatal development of the head and neck and postnatal development of the jaws with some discussion of abnormalities in development which cause deformities of the teeth and jaws.

The fourth chapter is a review of the osteology, primarily of the patient's jaws, but with sufficient mention of the other bones of the skull to explain their relationship between these and the facial bones. This is followed by a chapter dealing particularly with the anatomy of the nose and paranasal sinuses, pointing out the possible common involvement of these and the oral structures by injury, disease or deformity.

In the next chapter the anatomy of the temporomandibular articulation is described and the author calls attention to such conditions as joint pain, dislocation, "clicking" and limitation of movement of the joint as well as complete ankylosis. He draws attention to the fact that, while roentgenograms of the temporomandibular articulation are of definite value, one should be cautious about diagnosis, as a great portion of the joint remains obscure.

The seventh chapter is devoted to a discussion of the common anatomical landmarks as they appear in roentgenograms of the teeth and skull. The chapter is illustrated by the reproduction of several intraoral films and extraoral films illustrating the structures of which the

author speaks. There are also photographs of a dry skull demonstrating the position of the head in obtaining the extraoral roentgenographic views illustrated. The positions of the head in obtaining these views are those commonly used in routine examination. Contrary to the opinion of the reviewer and others, the author states that the use of stereoscopic technique does not lend much assistance in the interpretation of extraoral films.

The next chapter is concerned with the anatomy of the muscles of the face and jaws and some practical consideration is given to the facial muscles which more commonly affect the alignment of the teeth. There is also a brief discussion of the roles of the muscles of mastication in displacement of fragments in fractures of the mandible. Maxillary fractures and fractures causing cranial injury are also considered.

The next chapter, dealing with the anatomy of the glands of the head and neck, includes the salivary, mucous and serous glands, the lacrimal, pituitary, thyroid and parathyroid glands. The benefit of the use of sialography in the examination of the salivary glands is discussed and mention is made of endocrine disturbances resulting from increased and decreased function of the pituitary, thyroid and parathyroid glands.

In the chapter on neurology, the chief cranial and autonomic nerves supplying the head and neck are described. The use of a general anesthetic for operations about the face and jaws is mentioned, while local anesthesia of the various regions is discussed in more detail. Motor nerve disturbances involving the muscles of the face, jaws and tongue and sensory nerve disturbances are mentioned briefly.

The eleventh chapter discusses the arterial supply, venous drainage and lymphatics of the head and neck and there is brief mention of hemorrhage and methods of control. The next chapter is concerned with the anatomy of oral infections in which the author gives very definite consideration to the important fascial spaces which are well illustrated by diagrammatic drawings. In this chapter also there is made brief mention of some of the more important diseases of the oral structures.

This is followed by a discussion of the anatomical aspects of wartime maxillofacial injuries in which are mentioned burns of various degrees, bleeding, respiratory difficulties and tracheotomy, fractures of the jaws and injuries to the tongue and floor of the mouth. There is also a review of the structures which might be involved by a projectile passing through the face, which is well illustrated by a diagrammatic drawing.

The next chapter is concerned with a brief but specific description of the structures which must be given special consideration in the restoration of missing teeth.

The author has very efficiently accomplished his purpose in presenting the practical anatomy of the head and neck. While, as he stated in the preface, the book was designed particularly for those in the practice of dentistry, this book would be of definite value to those concerned with the diagnosis of conditions resulting from abnormal development, disease, or injury of the anatomical structures of the face and jaws. Also, there is a list of 389 references which might well stimulate additional reading concerning the various phases of the subject.

Haven F. Doane

BOOKS RECEIVED

Roentgen Interpretation. By George W. Holmes, M.D., Board of Consultation, Massachusetts General Hospital and Clinical Professor of Roentgenology, Emeritus, Harvard Medical School, and Laurence L. Robbins, M.D., Radiologist-in-Chief to the Massachusetts General Hospital and Associate in Radiology, Harvard Medical School. Seventh edition, thoroughly revised. Fabrikoid. Price, $7.00. Pp. 398, with 266 illustrations. Philadelphia: Lea & Febiger, 1947.

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City; Clinical Professor of Surgery, New York University Medical College; Associate Editor, Sidney Rubenfeld, M.D., Visiting Radiation Therapist, Bellevue Hospital; Clinical Instructor in Surgery, New York University Medical College. Cloth. Price, $5.50. Pp. 416, with 287 illustrations. Chicago: Year Book Publishers, Inc., 1947.

Bone and Bones: Fundamentals of Bone Biology. By Joseph P. Weinmann, M.D., College of Dentistry, University of Illinois; Formerly at School of Dentistry, Loyola University, Chicago, and Harry Sicher, M.D., School of Dentistry, Loyola University, Chicago. Cloth. Price, $10.00. Pp. 464, with 289 illustrations. St. Louis: C. V. Mosby Company, 1947.

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Pathology of Tumours. By R. A. Willis, D.Sc., M.D., F.R.C.P., Sir William H. Collins Professor of Human and Comparative Pathology, Royal College of Surgeons, London. Formerly Pathologist to the Alfred Hospital, Consultant Pathologist to the Austin Hospital for Chronic Diseases and Lecturer on the Pathology of Tumours in the University of Melbourne, Australia. Cloth. Price, $20.00. Pp. 992, plus 52, with 500 illustrations. London, England: Butterworth & Co. (Publishers), Ltd.; St. Louis, Mo.: C. V. Mosby Company, 1948.

Cancer: Diagnosis, Treatment, and Prognosis. By Lauren V. Ackerman, M.D., Pathologist to the Ellis Fischel State Cancer Hospital; Assistant Professor of Pathology, Washington University School of Medicine, St. Louis, and Juan A. del Regato. M.D., Radiotherapist to the Ellis Fischel State Cancer Hospital; Formerly Assistant to the Radium Institute of the University of Paris. Cloth. Price, $20.00. Pp. 1115, with 745 text illustrations and 42 color reproductions. St. Louis: C. V. Mosby Company, 1947.

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DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

AN IMPROVED METHOD OF VISUALIZATION OF THE SIGMOID*

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LESIONS of the sigmoid are among the most elusive, even after a very careful examination. Roentgenoscopy, routine anteroposterior and left oblique views[2] before evaluation and post-evaluation roentgenograms give adequate information in the vast majority of the cases, but in the presence of unusually redundant loops of sigmoid the examiner may be unable to rule out, with any degree of certainty, the presence of an early lesion. The explanation lies

Fig. 1. Lateral view of the pelvis. The sigmoid loop is folded in the true pelvis.

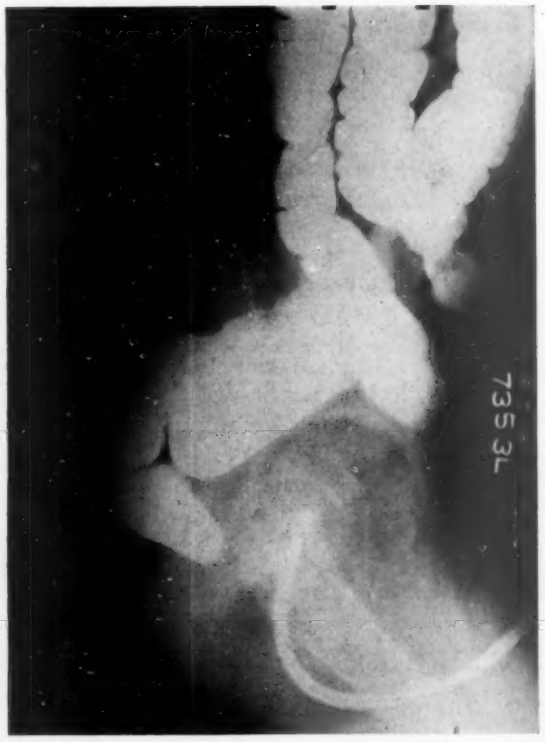

Fig. 2. Same subject after filling of the bladder. The sigmoid loop is pushed upward above the level of the symphysis pubis. The anterior wall of the rectosigmoid is clearly separated from the sigmoid. The perpendicular to the rectosigmoid is tilted about 35° to the head. It shows that if no tilt is given to the tube this section of the colon is foreshortened.

* The opinions expressed are the personal opinions of the author and neither the Medical Director nor the Veterans Administration endorses the opinions or assumes any responsibility for the same.

in the fact that there is compact folding of the loops deep in the true pelvis. This renders them inaccessible to thorough manipulation during roentgenoscopy, where at best only partial displacement and separation can be obtained.

By varying the position of the patient from prone to oblique or lateral decubitus one can improve visualization of the rectosigmoid and sigmoid loops. With the patient in supine Trendelenburg position the sigmoid falls partially into the false pelvis producing some separation of the loops, but in many cases the unfolding obtained is still inadequate. Nothing can be done to get roentgenograms with pressure and this deprives the examiner of one of the valuable techniques in the study of the gastrointestinal tract. The double contrast enema is not an adequate substitute.

A method described by Billing[1] gives a complete visualization of the sigmoid using various degrees of pressure. To my knowledge it has not been described in the American literature and its potentialities warrant its publication.

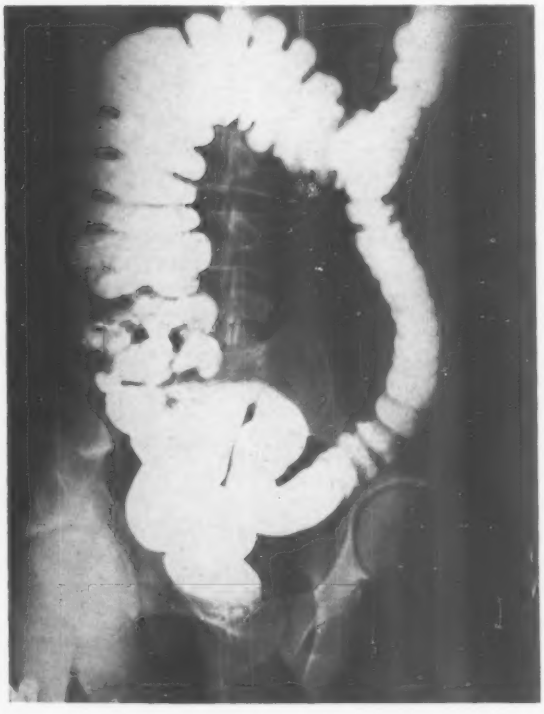

Fig. 3. Conventional left oblique view of the sigmoid.

Fig. 4. Left oblique view with 35° tilt to the head on the same subject after filling of the bladder. The rectosigmoid is well separated from the sigmoid loop which is stretched out. The pressure from the bladder has expelled most of the barium mixture from the upper portion of the loop. This pressure can be regulated by putting the patient in prone position lying on a compression bladder or cushion just above the symphysis.

When the bladder and the rectum are empty, the peritoneal cavity lying under the inlet has a volume of about 250 cc. Upon the filling of the rectum and sigmoid with the barium mixture the true pelvis becomes fully occupied but there remains enough room to accommodate the folded loops (Fig. 1).

Now, if the bladder is filled with an amount varying from 200 to 400 cc. of saline or water, according to the patient's tolerance, the bladder pushes the sigmoid from the true pelvis producing unfolding of the loops with separation from the rectosigmoid. A lateral view (Fig. 2) shows very plainly the anterior border of the rectum

and the sigmoid displaced upward above the symphysis. Figure 2 shows also that the rectosigmoid is about perpendicular to the plane of the inlet and, even if the patient is rotated to the left, it is still foreshortened. This can be remedied by tilting the beam 35° to the head. Figure 3 shows the routine left oblique view and Figure 4 shows, on the same subject, the left oblique view after filling the bladder and tilting the tube. Some improved unfolding and various degrees of pressure can be obtained if the patient lies prone on a compression bladder or cushion just above the symphysis.

These roentgenograms on normal subjects demonstrate the potentialities of this method. There is very little discomfort to the patient as the filling of the bladder is limited by urgency to urinate. Instead of filling the bladder with a catheter after the enema one can have the patient drink plenty of water and refrain from urinating. The sensation of fullness of the bladder is no great discomfort during the injection of the enema because, as the examination is focused on the sigmoid, it is not necessary to fill the colon entirely.

This method should be used when the clinical findings suggest a lesion of the rectosigmoid or sigmoid and the conventional barium enema is unsatisfactory due to redundancy.

SUMMARY

A method is presented to improve visualization of the sigmoid.

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Vol. 59, No. 5

PREVENTION BY ULTRAVIOLET RADIATION OF ALGAE FORMATION IN WASH TANKS

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ALGAE formation in wash tanks (especially the cypress wooden tank) has been a source of considerable annoyance, particularly during the warm, humid season. Frequent washings plus the use of either copper sulphate or formalin have been of some, but limited, avail.

It has been our experience that by first withdrawing the water, then exposing the compartment of the tank to ultraviolet radiation (we use one of the General Electric or Westinghouse sun lamps) we can obtain a considerably longer period wherein there is no algae formation.

Quincy City Hospital
Quincy 69, Mass.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

CARROLL, D. G.: Cerebral involvement in schistosomiasis japonica..... 755

INGRAHAM, F. D., and SCOTT, H. W.: Craniopharyngiomas in children..... 755

Neck and Chest

NEW, G. B.: Congenital cysts of tongue, floor of mouth, pharynx and larynx..... 756

SWEET, R. H.: Carcinoma of esophagus and cardiac end of stomach..... 756

LAHEY, F. H., and WARREN, K. W.: Tumors of carotid body..... 757

OLIVER, D. R., and SUGARBAKER, E. D.: Significance of skin recurrences following radical mastectomy..... 758

JONES, JOHN C.: Surgical aspects of bronchogenic carcinoma..... 758

MAIER, H. C., and TAYLOR, H. C.: Metastatic chorionepithelioma of the lung treated by lobectomy..... 759

SONTAG, L. W., and ALLEN, J. E.: Lung calcifications and histoplasmin-tuberculin skin sensitivity..... 760

HARDY, J. B., and HARTMANN, J. K.: Tuberculous dactylitis in childhood..... 760

PRUVOST, P., and DEPIERRE: Cavities with diverticula..... 761

MÉTRAS, H., and THOMAS, P.: "Round bell image" in chest roentgenography..... 761

Skeletal System

PINCUS, J. B., GITTLEMAN, I. F., and KRAMER, B.: Juvenile osteopetrosis..... 761

KESTLER, O. C.: Unclassified premature cessation of epiphyseal growth about the knee joint..... 762

HINDENACH, J. C. R.: Recurrent posterior dislocation of shoulder..... 762

ROWEN, R. E.: Roentgenographic features of metastases of retinoblastoma to long bones..... 762

FERGUSON, A. B., JR.: Calcified medullary defects in bone..... 763

RAY, R. B., and COUGHLIN, E. J., JR.: Osteochondritis dissecans of the talus..... 763

POWELL, N. B.: Osteitis pubis..... 763

PONSETI, I., and BARTA, C. K.: Osteoid osteoma..... 764

HODGEN, J. T., and FRANTZ, C. H.: Subperiosteal giant-cell tumor..... 764

CAFFEY, J.: Prenatal bowing and thickening of tubular bones, with multiple cutaneous dimples in arms and legs..... 764

PENDERGRASS, R. C., WALKER, A. E., and BOND, J. P.: Extraspinal lumbar meningocele..... 765

Blood and Lymph System

EDITORIAL: Infectious mononucleosis..... 765

ELKIN, D. C., and WARREN, J. V.: Arteriovenous fistulas..... 766

General

EDITORIAL: Hormones and cancer..... 767

GREENE, R. R., and PECKHAM, B. M.: Vitamin B complex, menorrhagia, and cancer..... 767

TOOMEY, J. A., and MORISETTE, R. A.: Hypervitaminosis A..... 767

TROXLER, E. R., and NIEMETZ, D.: Generalized xanthomatosis with pulmonary, skeletal and cerebral manifestations..... 768

GILL, DOROTHY: Multiple myeloma simulating hyperparathyroidism..... 768

FRIEDMAN, L. L., and SIGNORELLI, J. H.: Blastomycosis..... 768

ROENTGEN AND RADIUM THERAPY

CASE, J. T.: Radiation injuries..... 769

CONLEY, J. J.: Cancer of the mouth..... 770

GRIFFITH, G. C., and HALLEY, E. P.: Treatment of rheumatic fever by roentgen-ray irradiation..... 770

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Carroll, Douglas G. Cerebral involvement in schistosomiasis japonica. *Bull. Johns Hopkins Hosp.*, April, 1946, *78*, 219–234.

This report includes 5 cases, all occurring on the Island of Leyte in American troops in good health without previous exposure to this illness. In all except one case, the neurological manifestations took place in the acute stage. All cases occurred within seven months of exposure.

Four of the reported cases showed neurological involvement in the acute stage of the disease and one case showed neurological involvement four months after the acute stage. Those occurring in the early stage showed acute onset of drowsiness followed by coma and incontinence. There were signs of pyramidal tract involvement with weakness, spasticity, and exaggerated deep reflexes. There was moderate eosinophilia. Symptoms improved with therapy. Neurological involvement in the late stage was manifested by jacksonian convulsions, followed by the development of hemiplegia, but without drowsiness, coma, or incontinence.—*James J. McCort.*

Ingraham, F. D., and Scott, H. W. Craniopharyngiomas in children. *J. Pediat.*, July, 1946, *29*, 95–116.

Thirteen per cent of intracranial tumors in childhood are craniopharyngiomas. They are especially important because they can produce blindness, disorders of growth and metabolism and obstruction of the ventricular system. They are benign and therefore theoretically curable. They are due to proliferation of squamous cell rests from the buccal pouch, components of the original forward wall of Rathke's pouch.

This report is based on a study of 16 craniopharyngiomas seen at the Children's Hospital in Boston from 1932–1945. Two cases are reported in detail. The first case was a seven year old female child whose skull films showed suprasellar calcification and separation of the cranial sutures. This child died from recurrence after several operative attempts to remove the tumor.

The second case was that of a thirteen year old boy who complained of progressive loss of vision of eight months' duration. Roentgenograms of the skull showed prominent convolutional markings and slight separation of the cranial sutures. There was some atrophy of the posterior clinoid processes. There were no unusual intracranial calcifications. At operation a craniopharyngioma was found and removed as completely as possible. Roentgen irradiation with 3,000 r was given postoperatively. The authors plan to continue aspirations of the cyst and roentgen therapy when symptoms recur.

Cushing reported 4.6 per cent incidence of craniopharyngiomas in a series of 2,000 verified intracranial tumors. At the Children's Hospital there was an incidence of 6.3 per cent of 190 intracranial tumors in children under fifteen years of age.

The commonest symptoms were headache and vomiting. Progressive loss of vision was the commonest complaint among adults with this tumor. This was the second most common complaint in the 16 children studied in the present series. Arrested growth, weight loss, diabetes insipidus and mild convulsive seizures were less common complaints.

The commonest positive physical findings were in studies of the ocular fundi and visual fields. All 16 cases showed changes in the optic discs on ophthalmoscopic examination. Five children were undersized. Routine laboratory studies were not particularly informative, Skull roentgenograms showed abnormalities in all 16 cases. Suprasellar calcifications were present in 8 of the cases and intrasellar calcifications in two. Roentgen evidence of increased intracranial pressure was noted in 7 cases. The sella was enlarged and distorted in 8 cases.

Most of the lesions which might cause difficulty in differential diagnosis such as pituitary adenoma, meningiomas, aneurysms of the circle of Willis, etc., are rare in children.

Craniopharyngiomas are benign, and theoretically surgical removal should result in cure. However, total removal is rarely possible, be-

cause of the anatomical structures which lie in intimate relationship with the tumor. Surgical evacuation of the cyst and partial removal of the cyst wall is usually all that is feasible, and provides symptomatic relief and preserves vision for varying periods.

Roentgen therapy was first suggested by Frazier and his associates in 1937. Irradiation probably alters the secretory character of the cells producing the fluid. Preliminary surgical interference is necessary to establish the diagnosis and to prevent loss of vision.

The authors conclude that patients with late recurrence, who have had a relatively long remission following partial removal of the cyst should have repeated surgery while those with early recurrences and no serious reduction in visual acuity should have roentgen therapy.—*Rolfe M. Harvey.*

NECK AND CHEST

NEW, GORDON B. Congenital cysts of the tongue, the floor of the mouth, the pharynx and the larynx. *Arch. Otolaryng.*, Feb., 1947, *45*, 145–158.

Ranula. This term should be used only to designate a thin-walled, epithelium-lined cyst of the anterior part of the floor of the mouth which grows slowly, is sometimes of bluish tinge, and is soft and easily compressible. It is generally thought to be due to an obstruction of a duct of the sublingual gland but this does not seem plausible in all cases because of the bilateral nature of the cyst in some instances and because only a part of the gland may be affected. It is readily distinguished from the dermoid cyst owing to the thinness of its wall. These cysts may be removed surgically.

Cystic Hygroma. This is a multilocular lymph cyst which usually occurs primarily in the neck but may involve the floor of the mouth. The cyst is usually found in the floor of the mouth or in the submental or submaxillary region. It is a multilocular lymph cyst which has thin walls and an endothelial lining; it is usually filled with clear lymph. It is a retention cyst due to obstruction or lack of development of afferent lymph vessels. Lymphangioma or hemangioma of the floor of the mouth presents the same clinical picture except for the color of the angioma and the granular appearance of the lymphangioma. Microscopically, cystic hygroma and lymphangioma cannot be distinguished. These cysts may be treated with external radiation or radon seeds.

Dermoid Cyst. A dermoid cyst which involves the floor of the mouth and the submental and submaxillary regions may be situated either above or below the mylohyoid muscle or may extend from one region to the other through the muscle. In the majority of cases the cyst occurs in the midline but it may be situated laterally. Microscopically, the dermoid cyst has a thick fibrous capsule and a dermoid lining. A sinus may be present in the floor of the mouth or on the dorsum of the tongue where the contents of the cyst may be discharged.

Thyroglossal Cyst. The thyroglossal cyst is lined by stratified or ciliated epithelium. The thyroglossal duct is present in the embryo four weeks of age but normally atrophies during the sixth week of fetal life. An aberrant thyroglossal cyst may cause repeated inflammatory swelling of the base of the tongue if it becomes infected. If a portion of the cyst remains below the hyoid bone it produces swelling in the neck or a thyroglossal sinus externally in the midline. If there is incomplete obliteration of a thyroglossal duct and a portion remains in the region of the foramen cecum, repeated infection may cause a great deal of trouble.

Branchial Cyst. The branchial cyst may be present laterally in the pharynx in the region of the posterior pillar, or below the tonsil, or in the hypopharynx and at the base of the tongue.

Laryngeal Cyst. The congenital cyst of the larynx may not produce symptoms until adult life but may cause death once the larynx becomes obstructed by the mass present at the base of the epiglottis and the side of the larynx. Treatment is surgical removal.—*Mary Frances Vastine.*

SWEET, RICHARD H. Carcinoma of the esophagus and the cardiac end of the stomach. *J. A. M. A.*, Oct. 25, 1947, *135*, 485–490.

Until 1938 when Phemister and his associates performed the first successful transthoracic resection for carcinoma of the lower end of the esophagus invading the cardia, the prospect of treatment of this disease was dismal if not hopeless. As a result of several years of experience with resection and primary anastomosis within the thorax, the entire situation has changed, and the immediate and late results of treatment by resection and primary esophagogastric anastomosis may be evaluated.

The first transthoracic resection for carcinoma of the cardia to be performed at the Massachusetts General Hospital was in 1939. From then until Jan. 1, 1947, 213 patients with carcinoma of the esophagus or cardiac end of the stomach have been operated. on. Resections were performed in 141 cases. The first patient at the Massachusetts General Hospital in whom the esophagus was pulled up from beneath the aortic arch for the performance of a supra-aortic anastomosis was treated in May, 1944. Since that time 50 patients with carcinoma of the mid-thoracic segment have been treated by resection and high anastomosis. Twenty-one of these had an anastomosis just below the aortic arch, and in 29 the anastomosis was performed above the arch, frequently just below the dome of the left pleural cavity.

The most important development has been the routine use of penicillin and more recently of streptomycin for the prevention of infection. The use of these antibiotics has almost eliminated the element of sepsis. Other changes such as elimination of the continuous use of the inlying Levin tube, earlier ambulation, more frequent application of the operation of ligation of the superficial femoral veins to prevent pulmonary embolism and earlier administration of oral feedings are features of minor importance. All patients are now given the benefit of consultation with a cardiologist, who has taken a serious interest in the possibility of reducing the occurrence of cardiac complications. The routine use of a low sodium diet to diminish the possibility of the development of acute pulmonary edema and the preoperative and postoperative administration of quinidine sulfate in an effort to prevent the occurrence of cardiac arrhythmias appear to have been highly beneficial.

Contraindications to operation include obvious evidences of incurability such as the presence of distant metastases or involvement of the liver, a persistent fever or an intense boring pain in the back, both indicative of deep ulceration and infection, and, in the case of mid-thoracic lesions, bronchoscopic evidence of invasion of or fixation to the trachea or bronchi.

Complications occurring after resection include infection (empyema, mediastinitis, wound sepsis), cardiac disorders (myocardial infarction, congestive failure, auricular flutter, auricular fibrillation), pulmonary complications (embolism, pneumonia, atelectasis), vascular disorders (thrombosis of splenic vein, thrombophlebitis of leg veins) and miscellaneous conditions (uremia, chylous hydrothorax, acute parotitis, leakage from anastomosis, surgical shock).

In the early postoperative period the most frequent single cause of death was congestive failure of the heart, which accounted for 9 of the 23 fatalities. The next most frequent cause of death was sepsis, which occurred in 5 cases. The majority of fatalities from metastases or recurrence of the disease occur during the first two years after operation. Of 91 patients operated on for carcinoma of the lower part of the esophagus and cardia, there were 30 whose operation was performed three or more years ago. Seven of these patients died as a result of operation, leaving 23 who had an opportunity to survive. Nine of these 23 patients were alive three or more years after operation. This represents a three year survival rate of 39 per cent. Of the 50 patients in whom resection of carcinoma of the mid-thoracic esophagus was performed since 1944, there were 11 hospital deaths. Of the 39 surviving, 8 had their operation in 1944 and 3 of these are alive and apparently well over two years after operation. The others were operated on too recently to permit satisfactory studies of the end result, but the greatest number of deaths occurred during the first twelve months after operation.

In carcinoma of the esophagus the most distressing symptom is dysphagia. It has been a gratifying observation that even in those who die of recurrent or metastatic disease following resection with esophagogastric anastomosis there seldom develops a recurrence at the anastomotic stoma. The duration of palliation obtained by the use of this surgical procedure in cases of carcinoma of the esophagus and cardia varied from six months to four years. As a method of palliation alone, resection and anastomosis has been proved superior to any other form of treatment yet available in the management of carcinoma of the esophagus and cardiac end of the stomach.—*Samuel G. Henderson.*

Lahey, Frank H., and Warren, Kenneth W. Tumors of the carotid body. *Surg., Gynec. & Obst.*, Sept., 1947, *85*, 281–288.

The authors report on 18 carotid body tumors observed at the Lahey Clinic.

The four laterally located tumors of the neck which are single, discrete, and movable in character are branchial cysts, carotid body tumors, single large lateral aberrant thyroids and neuro-

fibromas. They are found in about the order stated in frequency of occurrence. The most frequent differentiation which will have to be made is between branchial cyst and carotid body tumor, and while this differentiation will be at times difficult, if not impossible, there are some quite distinguishing features to each of these conditions.

The tracts of the branchial sinuses are so superficial in location that in most instances, with traction upon the fistulous opening (so often at the level of the cricoid and just in front of the sternomastoid) the branchial sinus tract can be made to stand out so that it can be readily palpated directly under the skin. The cysts, forming as they do in the lower half of the tract, are superficial in character and located as a rule well below the level of the division of the carotid. They tend as they enlarge, to bulge outward upon the neck and become more and more superficial.

In contradistinction, carotid body tumors are located in the carotid notch so that they originate at a higher level and are more deeply located. As they enlarge, they do so upward under the angle of the jaws and at times inward until they may bulge into the pharynx and interfere with swallowing.

In approximately 75 per cent of cases the carotid body tumor is entirely asymptomatic. The lesions grow very slowly in most instances. Pathologically, it is estimated that 15 to 20 per cent of carotid body tumors are malignant. Malignancy, when it does occur, is of low grade.

The authors' preoperative diagnoses were correct in only 50 per cent of the 18 cases of carotid body tumors.

Since aberrant thyroid tumors are frequently malignant and since branchial cysts can so readily be removed and since some carotid body tumors can be demonstrated by exploration to be safely removable, all laterally located, discrete, and movable neck tumors should be explored.—*Mary Frances Vastine.*

OLIVER, DAVID R., and SUGARBAKER, EVERETT D. The significance of skin recurrences following radical mastectomy. *Surg., Gynec. & Obst.*, Sept., 1947, *85*, 360–367.

While radical mastectomy has been universally adopted as the most effective method of dealing with carcinoma of the breast, the reported incidence of skin recurrence following this procedure remains at between 10 and 30 per cent.

It appears that skin recurrences indicate that not all of the carcinoma was accessible to the surgeon at operation, regardless of how radical his procedure, and that the cancer was inoperable.

This concept is based upon the fact that the route of metastasis of breast carcinoma to the skin is usually by the superficial fascial lymphatic plexus with vertical growth into the skin. Permeation and embolization in retrograde lymphatic flow are probably the chief modes of metastasis, the latter appearing to be the one of primary importance.

Skin recurrence is probably only an indicator of the recrudescence of more widespread disease already clinically apparent or soon to become so. It is the authors' opinion that treatment of the recurrence, either surgical or radiotherapeutic, adds little or nothing to the patient's life expectancy.

It is believed by some workers that patients with advanced but still technically resectable carcinomas live less long after operation than do those who are refused radical mastectomy.—*Mary Frances Vastine.*

JONES, JOHN C. Surgical aspects of bronchogenic carcinoma. *J.A.M.A.*, May 10, 1947, *134*, 113–115.

Carcinoma of the lung contributes 10 per cent of all adult male cancers coming to autopsy and is second only to carcinoma of the stomach. The symptoms are essentially the same as those of inflammation and depend on the location and size of the tumor and the degree of obstruction and ulceration of the bronchus. The great majority of the patients complain of cough as the earliest symptom. Pain is the second most common symptom; it varies from a discomfort, feeling of tightness, oppression or a characteristic pleuritic pain of varying degrees to the severe intractable pain due to tumor invasion of the brachial plexus and the intercostal nerves. Hemoptysis occurs in more than half of the patients. There is nothing characteristic about it; slight or occasional streaking all the way to fatal hemorrhages may occur. Weight loss is a rather constant complaint, and is usually greater in the patients who have considerable infection complicating the tumor. Dyspnea occurs in about a fifth of the patients and commonly accompanies the pleural effu-

sions. Late manifestations include hoarseness, Horner's syndrome, phrenic nerve paralysis, intractable pain with involvement of the intercostal nerves and the brachial plexus and the cervical, axillary and supraclavicular metastatic lymph nodes.

The relatively late diagnosis of carcinoma of the lung is due either to a patient seeking medical advice long after the onset of his symptoms or the physician's failure to recognize the importance of the patient's complaint. Clinical improvement following chemotherapy without a complete roentgenologic clearing of a bronchopulmonary lesion in an adult is indicative of at least a tentative diagnosis of primary bronchogenic new growth until proved otherwise. Roentgenography is the greatest single diagnostic aid at our disposal, and it suggests the diagnosis in the vast majority of cases. The tumor itself may cast the entire shadow where the lesion (peripheral) arises farther out in the bronchial tree. A tumor arising in a primary or a secondary bronchus (central lesion) does not cast a distinct shadow of its own but one of atelectasis. Finally, a third type of roentgen manifestation may be evidence due to bronchiectasis, abscess or pleural effusion secondary to the primary tumor. Only in certain selected cases is bronchography indicated; namely, where the tumor is small and the bronchoscopy has not aided in the diagnosis, and a filling defect is searched for in the bronchus outlined by the iodized oil. Tomograms or planigrams have been of great aid when the lesion was well beyond the vision of the bronchoscope and biopsy was impossible. Bronchoscopy is the next most important diagnostic aid. A biopsy should be taken if possible to clinch the diagnosis. Bronchoscopy may yield important information, such as narrowing and fixation of the bronchi, even though the tumor arises beyond the visual field of the bronchoscope.

It is now generally agreed that all cancer of the lung arises from bronchial mucosa and is of a high grade malignancy. There are, generally speaking, three groups or classifications: squamous cell (epidermoid), adenocarcinoma, and undifferentiated cell types. Adenocarcinoma and undifferentiated carcinoma are much more rapid than the epidermoid type in their progress and have a higher incidence of metastasis and a much lower surgical operability and therefore a poorer prognosis. Roentgen therapy at best offers the patient only palliation in lesions that are radiosensitive and is reserved for cases that are inoperable. Total pneumonectomy with resection of the regional mediastinal, subcarinal and azygos lymph nodes is the only operation that offers a cure. The author describes in detail the technique of operation.

In 196 cases of carcinoma of the lung, only 39 per cent were clinically operable, and when exploration in 66 cases of this group was done only 39 were operable and had pneumonectomy. Of these patients 2 died in the hospital, and 11 died later. Twenty-six patients remain alive, and a number of these will probably die of recurrence or metastases.—*Samuel G. Henderson.*

MAIER, HERBERT C., and TAYLOR, HOWARD C. Metastatic chorionepithelioma of the lung treated by lobectomy. *Am. J. Obst. & Gynec.*, April, 1947, *53*, 674–677.

Although a chorionepithelioma is usually a highly malignant tumor, it may at times manifest an extraordinary digression from the usual clinical course. Unless hysterectomy is performed early, many cases go on to a rapid, fatal termination. Pulmonary metastases occur frequently and often grow rapidly, and are important factors in mortality. Some cases of chorionepithelioma, however, run an atypical course. Cases have been reported in which there was incomplete removal of tumor tissue at the time of hysterectomy, and yet the remaining tumor disappeared spontaneously and the patient was well even years after operation. Regression and even disappearance of pulmonary metastases, either spontaneously or following radiation therapy, have been reported. Whereas an analysis of the literature reveals an appreciable number of cases of spontaneous disappearance of residual tumor in the pelvic region, there are only a small number of cases on record in which recovery has followed the presence of definite pulmonary metastases.

Cases of so-called ectopic chorionepithelioma have been reported in which no evidence of a primary tumor was found in the pelvic organs. Therefore, in some cases the chief factor in management is control of the metastatic lesion. The case which the authors report falls into this categroy.

Summary. A case of metastatic chorionepithelioma of the lung successfully treated by lobectomy is reported. The Aschheim-Zondek test which was positive prior to operation became negative following lobectomy. Panhys-

terectomy performed a month after lobectomy failed to reveal any evidence of disease in the pelvic organs. The patient is well and free of evidence of disease over three years following pulmonary lobectomy. The plan of therapy pursued in this case could be feasible only in a very small percentage of cases of chorionepithelioma.—*Mary Frances Vastine.*

SONTAG, L. W., and ALLEN, J. E. Lung calcifications and histoplasmin-tuberculin skin sensitivity. *J. Pediat.*, June, 1947, *30*, 657–667.

Serial chest films have been made by the authors on a group of 200 normal southwestern Ohio children at yearly intervals since birth. Skin sensitivity tests were made at the same time. This forms a basis for a comparison of the incidence of pulmonary calcifications in association with positive skin tests. Children from all economic levels were included in the study. With the use of serial films it is possible to trace the development of calcifications back to their origin, and note the appearance and nature of the original lesion.

In addition to skin tests for tuberculosis and histoplasmosis the group was also tested for sensitivity to *Haplosporangium parvum* and blastomycin. One hundred seventy children were tested with tuberculin and histoplasmin; 26, or 15.3 per cent, were positive to PPD and 76, or 44.7 per cent, were positive to histoplasmin; 130, or 60.6 per cent, had pulmonary calcifications. The studies showed a much more rapid increase in the development of pulmonary calcifications than in the development of tuberculin sensitivity in the younger age groups. This was only true in the earlier age groups. Beyond the age of fifteen the incidence of pulmonary calcifications became fairly constant while the number of positive tuberculin reactors continued to increase.

The authors noted striking similarity in the incidence of histoplasmin sensitivity and pulmonary calcifications in contrast to the dissimilarity of tuberculin sensitivity and pulmonary calcifications. Thirty-three of the children with pulmonary calcifications were not sensitive to tuberculin or histoplasmin. Of these 33 one was sensitive to haplosporangin and 2 to blastomycin.

Serial studies enabled the authors to distinguish between questionable calcifications and bronchi or blood vessels. They found parenchymal lesions at the bases much more commonly than at the apices. The initial lesions varied from fan-shaped infiltrations and exaggerated linear markings to rounded areas of consolidation up to 2.5 cm. in diameter. Calcifications began twelve to fifteen months after the appearance of the lesion. Calcification of the draining hilar nodes did not occur for two years or more.

The authors were unable to establish calcification patterns by which histoplasmin and tuberculin reactors could be distinguished.—*Rolfe M. Harvey.*

HARDY, J. B., and HARTMANN, J. K. Tuberculous dactylitis in childhood; a prognosis. *J. Pediat.*, Feb., 1947, *30*, 146–156.

Twenty-one cases of destructive tuberculous lesions of the small bones of the hands and feet have been selected from cases followed at the Harriet Lane Home. Each had a positive tuberculin skin test and negative Wassermann reaction. All but 3 had roentgen evidence of pulmonary or mediastinal tuberculosis. All were less than fourteen years of age when first seen. Nine had a history of exposure to sputum-positive cases of tuberculosis. The incidence of tuberculous dactylitis was 0.6 per cent in a series of 610 cases of tuberculosis in children under two years of age.

Seventy-six per cent of the cases were in Negro patients; 67 per cent were under two years of age. Clinically the patients showed a fusiform, indurated, usually painless swelling over the affected digit. The overlying skin was tense, shiny and red. Fistulas developed in 8 cases. Dactylitis was either the presenting complaint or an early sign in 19 of the 21 cases.

The roentgen changes varied from minimal medullary destruction with periosteal cloaking to "ballooning" of the cortex and marked destruction. Follow-up films usually showed good bone regeneration and restoration of function. The terminal phalanges were not involved in any case. Forty-eight bones of the hands were involved as compared to six bones of the feet; 55 per cent of the lesions were in the proximal phalanges.

Patients in whom the dactylitis was only a minor manifestation of a severe generalized infection had a mortality of 100 per cent. In those patients with mild tuberculous infections no deaths occurred. Thirteen months to three years was required for healing, depending on the severity of the infection. Treatment in all cases should be conservative splinting or casting.—*Rolfe M. Harvey.*

Pruvost, P., and Depierre. Les cavernes diverticulaires. (Cavities with diverticula.) *Presse méd.*, Dec. 25, 1946, *54*, 858–859.

Several cases of tuberculous cavities were studied by direct injection of lipiodol into the cavity under fluoroscopic control. The conventional films and tomograms had failed to demonstrate extensions of the ulcerative process which were visualized by the use of lipiodol. Some of these sinuses or diverticula were extending far away from the main cavity, occasionally through interlobar septa or toward the parietal pleura. In the hands of the authors, no ill effects were noted following these injections. The presence of such ramifications apparently complicates those surgical procedures which aim at the collapse or permanent drainage with aspiration (Monaldi's technique) of the cavities. Such extensions probably explain some failures of surgical treatment, despite the fact that on serial films the cavities originally visualized are apparently well collapsed. The authors recommend that the lipiodol injections be used more often before instituting treatment.—*Gilbert H. Fletcher.*

Métras, H., and Thomas, P. "L'image en grelot" en radiologie pulmonaire. ("Round bell image" in chest roentgenography.) *Presse méd.*, Oct. 2, 1946, *54*, 644–645.

The authors describe an image seen in chest roentgenograms which resembles a small round bell and is produced by a cavity containing a bolus of soft tissue density. The circular or oval wall of the abcess cavity constitutes the peripheral component of the image. The central component varies according to the size of the material therein. If the bolus is comparatively small, it is seen as a round shadow located at the lower pole of the radiolucent image. If the material occupies most of the cavity, a crescent-shaped air shadow is seen at the upper pole. If it is thin, it will only be seen if the central rays happen to be tangential to it. After injection of lipiodol into these cavities, one gets irregular puddles and streaks of the radiopaque material distributed around the central body.

In 3 of the cases reported, the soft tissue mass was composed of mycelial growth inside of a chronic abcess in 2 instances and lung cyst in the third. The roentgen picture of the fourth case was most puzzling. It was made of an oval, air-filled cavity adjacent to the left lateral chest wall with a round soft tissue mass protruding inside, having its base on the chest wall. This lesion was subsequently demonstrated to be a pleural metastasis from a carcinoma of the esophagus, protruding into an abcess cavity.

The authors mention that these "round bell images" have been described in dermoid or hydatid cysts when the fluid had escaped, leaving only the solid material.—*Gilbert H. Fletcher.*

SKELETAL SYSTEM

Pincus, J. B., Gittleman, I. F., and Kramer, B. Juvenile osteopetrosis; metabolic studies in two cases and further observations on the composition of the bones in the disease. *Am. J. Dis. Child.*, April, 1947, *73*, 458–472.

Two cases of osteopetrosis are reported with complete metabolic studies. The first infant's roentgenograms of the long bones showed features characteristic of osteopetrosis and also of healing rickets. In the second case, the roentgenograms of the long bones revealed evidence of osteopetrosis but failed to show changes in the epiphyses and metaphyses of either healing or active rickets. The patient, however, did show chemical evidence of florid rickets.

The authors state that up to the time of their report only one well controlled mineral metabolic study of both calcium and phosphorus was done on a child suffering from marble bones. This study failed to throw any light on the presence or absence of a metabolic disorder in the disease because of coexisting rickets. They believe that rickets seems to be regularly associated with juvenile osteopetrosis. In their study they found that 70 to 80 per cent of the total phosphorus excreted was present in the urine, characteristic of rickets in the healing state, in the patient with healing rickets. In the patient with florid rickets a similar condition was found, namely, 80 per cent of the phosphorus excreted was lost by way of the urinary tract. Therefore, they concluded, a disturbance other that associated with the presence of rickets had to be taken into consideration. This finding has never been reported in uncomplicated rickets.

On the basis of the results they obtained in the complete and detailed metabolic studies, they conclude that while a congenital malformation of the primordial mesenchymal cell may exist, an associated metabolic disturbance is present which in its manifestations resembles a chronic state of hyperparathyroidism. They could not determine whether this disturbance was of maternal or fetal origin.

Their studies of the chemical composition of marble bones confirmed previous observations in an uncomplicated case. The findings consisted of hypermineralization, as indicated by a high ratio of inorganic to organic matter and an increase of the molecular ratio of calcium carbonate to calcium phosphate.—*R. S. Bromer.*

KESTLER, OTTO C. Unclassified premature cessation of epiphyseal growth about the knee joint. *J. Bone & Joint Surg.*, July, 1947, *29*, 788–797.

Premature arrest of epiphyseal growth about the knee joint, following tuberculosis of the hip, has been described. However, Kestler states, premature cessation of growth may occur in the epiphyseal plates about the knee as a result of hip disorders other than tuberculosis. He describes three types of unclassified cessation of epiphyseal growth about the knee:

Group I. This group includes infectious hip lesions, producing early secondary growth arrest about the knee. In addition to tuberculosis, he has observed the condition in a pyogenic infection of the hip caused by the hemolytic *Staphylococcus aureus* in childhood and another instance in a case of Still's disease.

Group II. In this group are included noninfectious hip disorders causing or connected with an early cessation of epiphyseal growth about the knee on the same side as the hip involvement. This type was demonstrated in an eighteen month old baby with unilateral congenital dislocation of the hip.

Group III. This group includes cases of premature cessation of epiphyseal growth about the knee without lesions in the hip on the affected side and without an associated pathological process demonstrable elsewhere.

Although a variety of factors should be considered when early cessation of growth occurs about the knee, either from a neighboring joint lesion or from apparently unknown cause, Kestler believes that the main factor producing these changes is the impaired blood supply to the growth centers. This impaired blood supply is caused by indirect action, affecting the arteries of the epiphyses; a reflex action explains the change in the epiphyseal plates. He believes that the theory which explains the changes merely on a mechanical basis is not acceptable. In addition to the impairment of the blood vessels, toxins produced by the various agents of infection must also play an important part. He cites the absence of pain and the presence of atrophy in support of the conception of an impaired blood supply. Bone atrophy is a contributing factor and trauma may also play a role. Destructive pathological changes in the hip, inflammatory in nature, usually produce varying degrees of atrophy in the lower part of the femur and the upper portion of the tibia, or in both, in the same lower extremity.— *R. S. Bromer.*

HINDENACH, J. C. R. Recurrent posterior dislocation of the shoulder. *J. Bone & Joint Surg.*, July, 1947, *29*, 582–586.

Posterior dislocation of the shoulder is a rare lesion. The diagnosis of the condition is often missed, as the disability may not be severe, and the range of motion may be only slightly limited. Palpation of the head of the humerus below the spine of the scapula and the presence of an abnormal hollow below the acromion are the salient features. Anteroposterior roentgenograms are very misleading, because they show a normal outline of the shoulder joint. Lateral views through the chest, or superior-inferior views through the axilla, display the abnormal position of the head of the humerus.

The recurrent and permanent types tend to be confused, and they overlap in the region of the shoulder. A shoulder may be dislocated posteriorly by trauma, and although adequate reduction may be performed, the dislocation may recur every few months following specific strain. This is the true recurrent type. However, following an original dislocation, the disability may recur every time the shoulder is abducted, or flexed and elevated. Such a condition, although recurrent, is also habitual. True habitual posterior dislocation, however, often occurs in young adults without history of primary injury, and it is commonly bilateral.

A case is reported and the operative method of reduction is given in detail. Roentgenograms are reproduced showing the dislocation with the result of operative reduction and the insertion of an iliac bone graft fitted into the posterior border of the glenoid rim and the neck of the scapula, after removal of a thin portion of the cortex of the rim and neck.—*R. S. Bromer.*

ROWEN, RALPH E. Roentgenographic features of metastases of a retinoblastoma to the long bones. *J. Bone & Joint Surg.*, July, 1947, *29*, 805–808.

In the case reported, the primary lesion was

retinoblastoma of the right eye, with metastases to the skull and long bones. The patient was a Negro boy, aged six years. Roentgenographic examination showed a mild atrophy of the lower end of the right humerus, swelling of the soft tissues, vertical striations of the periosteum and irregular areas of bone absorption. In a further examination of the skeleton, the same appearance was found in the upper portion of the left humerus. In the skull, irregular demineralization of the parietal bones was shown.

Several roentgenologists who examined the roentgenograms of the patient made the diagnosis of osteogenic sarcoma. The unusual youth of the patient, the lymph node metastases, and the multiplicity of lesions, combined with a normal alkaline-phosphatase determination, however, ruled out this diagnosis. In a search of the literature, little was found concerning the appearance of the metastases of a retinoblastoma to the long bones.—*R. S. Bromer.*

Ferguson, Albert Barnett, Jr. Calcified medullary defects in bone. *J. Bone & Joint Surg.*, July, 1947, *29*, 598–602.

Calcified medullary defects of bone appear in the roentgenogram as solitary, rounded areas, made up of irregular nodules of amorphous calcification, in or near the metaphyseal regions of the long bones. They are frequently located in the center of the medullary cavity and are of variable size, usually 1 to 2 cm. in diameter. When these areas are larger, they are likely to be confused with caisson disease in bone. The nodules are of even calcific density. The periphery of the lesion reticulates with the normal bone lines, but is sharply demarcated from normal bone structure. There is no central area of lesser density and no shell of calcification. As a rule, the lesions are solitary but in one of Ferguson's cases when the wing of the ilium was involved, the occurrence was bilateral. In another case, a lesion was found both in the wing of the ilium and the neck of the femur.

None of the patients complained of pain. All were in the age group of forty years or over, with one exception a male, aged twenty-four. In all cases the lesions were found during the search for pathological changes in the neighboring joint.

The fact that the lesion is symptomless helps to differentiate it from the following diseases in which other pathological processes are involved: caisson disease of bone, chondrodysplasia, osteoid osteoma, sclerosing osteogenic sarcoma, osteoplastic prostatic metastases, and bone infarcts.

The pathological and clinical findings lead Ferguson to the conclusion that the lesion is a degenerated calcified island of cartilage which did not progress to complete ossification at the time of skeletal growth. The solitary, non-symmetrical nature supports the contention that trauma may be an etiological factor. Rickets may also be mentioned in connection with the lesion.—*R. S. Bromer.*

Ray, R. Beverley, and Coughlin, Edward J., Jr. Osteochondritis dissecans of the talus. *J. Bone & Joint Surg.*, July, 1947, *29*, 697–706.

The authors report a series of 13 cases of osteochondritis dissecans of the talus with fourteen ankles involved, together with 3 additional cases through personal communication. The literature is reviewed since 1941. They state the paucity of the cases reported would seem to indicate that the condition is rare. However, with the condition in mind and with careful roentgenographic study they think the diagnosis will probably be made with increasing frequency. In their cases the lesion was located in the superomedial portion of the talus in 11 instances and in the superolateral location in 6 cases.

Anterolateral and lateral roentgenograms, they believe, do not always reveal the lesion. Careful oblique views will often demonstrate a lesion, hidden by one of the malleoli. Tomography, or laminagraphy although an adjunct in making the diagnosis, is not necessary routinely. A patient who presents a typical history of repeated sprains, with localized tenderness over the anterior aspect of the talus and negative roentgenographic findings, should be followed carefully, since subsequent roentgen examinations may disclose the lesion. Trauma is a major etiological factor, although 4 of their patients gave no history of ankle injury.

They recommend treatment consisting of excision of loose fragments and saucerization of the remaining defect in the articular surface of the talus. The surgical approach to the ankle joint should be considered carefully, and should be chosen only after roentgenographic study and determination of the exact location of the lesion.—*R. S. Bromer.*

Powell, Norborne B. Osteitis pubis. *J. Bone & Joint Surg.*, July, 1947, *29*, 785–787.

Osteitis pubis is a relatively infrequent com-

plication of suprapubic prostatectomy. The etiology of the condition is not known. In the roentgenograms of the case reported in this paper, the descending rami of the pubic bones showed some irregularity of outline with some suggestion of bone destruction. The diagnosis was osteitis pubis. Frequent roentgenograms showed later, a gradual healing process.

The history of a recent suprapubic operation, with physical findings of pain over a localized area of the symphysis pubis, is usually enough to suggest the diagnosis. Roentgenograms of the areas will usually prove the existence of the condition after about the third week. There is roughening or fraying of the periosteum and a moth-eaten appearance of the symphysis pubis and rami. Decalcification of the rami and inner portions of the ischia may become evident on subsequent roentgenograms. The disease is usually self-limiting with or without therapy, and in about six to ten weeks there is a recalcification and rapid reconstruction of the involved bones. Ankylosis of the symphysis pubis is the rule. Recovery is often slow and tedious.—*R. S. Bromer.*

Ponseti, Ignacio, and Barta, Chester K. Osteoid osteoma. *J. Bone & Joint Surg.*, July, 1947, *29*, 767–776.

Seven cases of osteoid osteoma are reported. One of the patients having an osteoid osteoma in a rib represents the first published report of this condition in this site. The ages of the patients ranged from fourteen months to twelve years. The main clinical symptom was localized pain, the duration of which varied from several months to one year. Roentgenograms of the lesions are reproduced together with histological sections of tissue removed at operation.

In 3 patients, peculiar deformities, produced by the presence of the osteoid osteoma, were noted. The patient with involvement of a rib had a total C curve of the spine which improved and finally disappeared after removal of the lesion. A fourteen month old child had a varus deformity of the ankle, produced by an osteoid osteoma in the lower end of the diaphysis of the fibula. Apparently in this patient the lesion had stimulated the growth of the lower epiphyseal plate of the fibula. In a third patient, an inward bowing of the tibia developed, caused by a lesion in the inner aspect of the upper portion of the tibia.

They describe the roentgenographic appearance of an osteoid osteoma as a small nidus-like, circumscribed area, either uniformly translucent or mottled with irregular and sclerotic bone. It is almost always surrounded by reactive new-bone formation, which is of moderate character when the lesion is located in spongy bone, but which becomes very pronounced when the osteoid osteoma is located in cortical bone. Usually the older the lesion, the more marked this reactive bone sclerosis becomes.

Their experience indicates that the treatment of osteoid osteoma must consist of an extensive block resection of the lesion, together with removal of a good deal of the surrounding sclerotic bone.—*R. S. Bromer.*

Hodgen, John T., and Frantz, Charles H. Subperiosteal giant-cell tumor. *J. Bone & Joint Surg.*, July, 1947, *29*, 781–784.

A case is reported which possessed the characteristics ascribed to giant-cell tumor of the subperiosteal type. The patient was a fifteen year old girl complaining of an aching pain of four months' duration in the region of the right knee. Roentgenograms revealed in the right tibial shaft a well demarcated, subperiosteal area of bone destruction on the medial surface. A lateral view localized the lesion on the posterior aspect. There was no bulging of the shaft and no periosteal reaction was present. The tumor was curetted and was closed and healed per primam.

In the opinion of the Army Institute of Pathology, the histologic sections suggested a reparative process following injury, even though no history of trauma could be elicited. The unusual position of the lesion in the diaphysis, close to the cortex, supported this conception, inasmuch as the standard type of "benign giant-cell tumor" is seen only within or near the metaphysis.

The authors quote Cone who in 1928 described a case of ossifying hematoma. In this type of lesion, proliferation of osteoclasts is brought about by hemorrhage and a disturbance of the normal blood supply of the bone, sometimes leading to abnormal osteoclasia or giant-cell tumor. In their case, healing occurred in the cortical bone and was recorded by roentgenograms made thirteen months after the operation.—*R. S. Bromer.*

Caffey, John. Prenatal bowing and thickening of tubular bones, with multiple cutaneous dimples in arms and legs; a congenital syn-

drome of mechanical origin. *Am. J. Dis. Child.*, Nov., 1947, *74*, 543–562.

Caffey reports the clinical and roentgeographic findings in 3 cases of prenatal bowing and thickening of the tubular bones in young children with also multiple dimpling of the skin of the extremities. He offers prenatal mechanical molding of the bones and pressure atrophy of the fetal skin as the probable pathogenic mechanisms. He also emphasizes the similarity of the bowed legs caused by prenatal bowing to the bowed legs due to rickets and to Blount's tibial osteochondrosis.

Each of the 3 infants had congenital symmetric bowing of the femoral and humeral shafts and similar, but sometimes unpaired, deformities of the shafts of the tibias, radiuses and ulnas. In each case the bowed diaphyseal segments were thickened, as well as bent. All the curvatures extended through substantial longitudinal segments of the shafts in or near their middle thirds. Large symmetric cutaneous dimples overlay the salient angles of the curves in several of the deformed long bones. No evidence of any intrinsic prenatal skeletal dysplasias such as achondroplasia or dyschondroplasia could be found. Likewise there was no sign of fragilitas ossium (osteogenesis imperfecta) or pseudoarthrosis, prenatal or infantile rickets or syphilis.

This type of nonrachitic bowing, Caffey states, could easily be mistaken for rachitic bowed legs, especially when no cutaneous dimples are present or their presence is interpreted improperly. It is also probable that some cases which have been reported as instances of infantile tibial osteochondrosis were actually examples of prenatal bowing of the bones in the legs.

Many of the deformities disappeared with advancing age, especially in the upper extremities, but many others were still present during the third year of life. All the neonatal dimples persisted during infancy without significant change with advancing age.—*R. S. Bromer.*

Pendergrass, Robert C., Walker, A. Earl, and Bond, John P. Extraspinal lumbar meningocele. *J. Neurosurg.*, Jan., 1947, *4*, 80–86.

In the case reported here the paraspinal meningocele was present in the lumbar region and a visible, palpable mass was present in the loin. On the left side of the back, extending from the 12th dorsal vertebra to the 4th lumbar vertebra, there was a large fluctuant, slightly tender mass. On coughing, the mass distended. Neurological examination was essentially normal. Roentgenograms of the spine revealed an absence of se spinous processes of the 11th and 12th thoracic vertebrae and of the left transverse processes of the 1st, 2nd, 3rd and 4th lumbar vertebrae. The tips of these transverse processes were visualized in the flank at the outer aspect of the mass. A lumbar myelogram was carried out, 5 cc. of pantopaque being injected. The canal appeared to be normal until the 12th interspace, at which point the pantopaque was seen to pass from the left side of the spinal canal through an opening into the large mass. A diagnosis of extraspinal lumbar meningocele was made. Surgical exposure of the meningocele with an attempt to close the neck was unsuccessful. A partial hemilaminectomy with ligation of the neck of the sac passing through the intervertebral foramen effected a cure.

The localization of the communication between the meningocele and the spinal subarachnoid space was made possible by pantopaque myelography. This knowledge made it possible to ligate the neck of the sac through a hemilaminectomy of only two vertebrae. Adequate treatment of such a condition appears to be obliteration of the communication between the subarachnoid space and the sac, since the fluid in the cyst seems to be more the result of the passage of spinal fluid from the subarachnoid space into the sac than fluid secreted by the sac wall.—*K. K. Latteier.*

BLOOD AND LYMPH SYSTEM

Editorial. Infectious mononucleosis. *J.A.M.A.*, Aug. 30, 1947, *134*, 1548–1549.

World War II disclosed that infectious mononucleosis is a more common disease than is generally realized. Notable features of this disease are its wide variety of clinical manifestations and physical findings. To emphasize these facts, Walker classified the 29 cases which he reported into six different types: respiratory, febrile, lymphadenopathy, exanthematous, gastrointestinal, and central nervous system. Certain symptoms are present in nearly all cases. These symptoms are weakness, headache, chilliness, sore throat, fever, anorexia and excessive perspiration. The respiratory type with sore throat, cough and pain beneath the sternum is

most common. An enlarged spleen was present in 25 of the 29 cases. Lymphadenopathy also is one of the most constant features. In epidemics of infectious mononucleosis skin eruptions may approach a 100 per cent incidence. The central nervous system manifestations may include, among others, dizziness, confusion, nystagmus, diplopia and a feeling of impending syncope. The main symptoms may arise from the gastrointestinal tract and simulate appendicitis, acute gastroenteritis or enteric fevers.

Two laboratory procedures aided in the diagnosis of many cases in the armed forces which otherwise might have remained unrecognized. A striking differential blood count is constant and typical in the shift toward an increase in mononuclear cells at the expense of the neutrophils. The lymphocytes show a relative and absolute increase of at least 50 per cent some time during the disease, and the lymphocyte is atypical, with definite characteristics in different patients. The heterophile sheep cell agglutinin test often helps to confirm the diagnosis. When the antibody titer is higher than 1:64 it is said to be strong evidence of the presence of infectious mononucleosis. Autopsy findings show that infectious mononucleosis is a generalized disease in which cellular infiltrations may develop in almost any organ. The clinical picture varies with the organs or systems predominantly involved. As the cause of infectious mononucleosis has not been determined, cases will probably continue to go unrecognized unless clinicians keep in mind its protean manifestations.—*Samuel G. Henderson.*

ELKIN, DANIEL C., and WARREN, JAMES V. Arteriovenous fistulas. *J.A.M.A.*, Aug. 30, 1947, *134*, 1524–1528.

The establishment of the centers for the treatment of vascular injuries in certain Army general hospitals afforded an unprecedented opportunity to study a large number of arteriovenous fistulas. At the Ashford General Hospital over 375 patients with arteriovenous fistulas were observed and treated by operative means.

Regardless of the site of the lesion, the local evidences of an arteriovenous fistula are similar. The most common sign is the bruit, or murmur, which can be heard with a stethoscope in the region of the fistula. If the murmur is of sufficient intensity, a thrill may be felt. The superficial veins near the fistula or distal to it are dilated and tortuous in most instances. In the early stages the area supplied by the artery distal to the fistula may show evidence of deficient circulation, varying from mild evidences of circulatory insufficiency such as pallor and coolness of the part to the more severe manifestations such as gangrene or cerebral anemia. In many patients there is an alteration in the size of the heart which can be detected only by the decrease in the transverse diameter of the heart as measured in the teleroentgenogram after operative eradication of the fistula. On only relatively infrequent occasions is this increased size in excess of the normal standards; therefore, it is noted only by the comparison of films made before and after removal of the fistula. Since the change is reversible soon after removal of the fistula, it is assumed that this enlargement represents dilatation rather than true hypertrophy. In patients with fistulas of long standing irreversible hypertrophy may occur.

Cardiac output measurements were made on 47 of the patients by means of the critically damped low frequency ballistocardiograph. This instrument is used to measure the cardiac output from the recoil of the body resulting from each heart beat. In slightly over half of the patients studied, the basal cardiac output is elevated above the level found in the same patient after operative removal of the fistula. Some patients were found to have an output as much as twice the normal value. Observations on the blood volume were made in 40 patients. Slightly over half of the patients showed no difference in blood volume before and after operative removal of the fistula. The remaining patients showed a significant decrease in blood volume after removal of the fistula. This change amounted to as much as 1,000 cc. per square meter of body surface.

Several circulatory changes occur on temporary occlusion of the fistula. Occlusion can be produced manually or with a blood pressure cuff. The most commonly recognized of the circulatory responses is the slowing of the pulse rate, usually referred to as Branham's sign. This occurs in almost all instances in which compression of the fistula is possible and has not been observed by the authors in any of the patients with simple arterial aneurysms. They believe that this slowing of the pulse rate is a valuable diagnostic sign in the differentiation of purely arterial lesions from those which involve an arteriovenous communication. The increase in the size of the heart in many patients with an arteriovenous fistula has been demonstrated

many times. It has been suggested that this is due to the increased blood volume but the authors' observations failed to demonstrate a good correlation between heart size and blood volume. It is believed that while the changes in blood volume may contribute some to the variation in cardiac size seen in these patients, other important factors probably exist. In patients with sustained increased demands on their hearts, such as those with severe anemia, thyrotoxicosis or hypertension, there may develop cardiac enlargement. The increase in the size of the heart in patients with arteriovenous fistulas may be on a similar basis. A more nearly complete and rational explanation of the genesis of the effects of an arteriovenous fistula on the circulation awaits an extension of our basic knowledge in regard to the circulatory system. —*Samuel G. Henderson.*

GENERAL

Editorial. Hormones and cancer. *J.A.M.A.*, Aug. 30, 1947, *134*, 1550.

Estrogenic materials have been used for the palliative treatment of carcinoma of the prostate gland to relieve the victim of some of the discomforts arising from this disease. The action apparently is not curative. More recently further interest has been aroused in the relation of endocrines to cancer with the discovery that testosterone may have some effect on mammary cancer. While testosterone seems to have a palliative effect in some cases of breast cancer, other cases may be made immeasurably worse. At times the cancer can be caused to progress rapidly. Until a thorough and extensive study of this problem can be made the medical profession should not be encouraged to use testosterone or any other steroid in the treatment of breast cancer. The problem is so important that the Therapeutic Trials Committee of the Council on Pharmacy and Chemistry has undertaken an exhaustive investigation of the use of testosterone and other steroids in mammary and later, other cancers. A report will be issued in the near future by a special subcommittee.—*Samuel G. Henderson.*

Greene, R. R., and Peckham, B. M. Vitamin B complex, menorrhagia, and cancer; a critical review. *Am. J. Obst. & Gynec.*, Oct., 1947, *54*, 611–617.

The authors' critical review of the literature is concerned with the function of the liver in the inactivation of estrogens; the effect of vitamin B complex deficiency on this function; the relation of vitamin B complex deficiency to various gynecologic disorders and to cancer of the uterus; and the therapeutic use of this substance in these conditions.

The clinical work is founded on the basic assumption that vitamin B complex deficiency renders the liver unable to inactivate estrogens. This leads to the accumulation of excessive endogenous estrogens which in turn causes menorrhagia or may, after prolonged action, cause carcinoma of the uterus. The validity of the theory is evidently destroyed.

Anorexia and weight loss are early symptoms of vitamin B complex deficiency. The subjects of these articles were not reported as having had such symptoms. In fact, in one article it was specifically stated that most of the patients were overweight. It seems doubtful that these patients, at least, actually were deficient.

It is postulated in these clinical articles that excessive endogenous estrogens result from the inability of the vitamin deficient liver to inactivate them. In the Biskinds' articles no specific evidence has been presented that excessive estrogens actually are present. Ayre and Bauld state that evidence of the presence of excessive endogenous estrogens was in their vaginal and cervical cytology smears, yet they do not present evidence to substantiate this claim. The known physiology of the vagina makes it unlikely.—*Mary Frances Vastine.*

Toomey, John A., and Morisette, Russell A. Hypervitaminosis A. *Am. J. Dis. Child.*, April, 1947, *73*, 473–479.

A case of hypervitaminosis A is reported, the features of which agree with the observations set down by Josephs: (1) hepatomegaly (but no splenomegaly), (2) increased levels of vitamin A in the serum, (3) increased level of serum lipids, (4) abnormalities of bones, (5) increased level of serum phosphatase, (6) low level of serum proteins, (7) sparse, coarse hair, (8) avid appetite for butter, (9) abnormal intake of vitamin A and (10) prompt recovery from pain when vitamin A was withheld.

The patient was a twenty-three month old infant. Before admission to the hospital the child had been breast fed, with supplemental formula feedings; later he had received meat, cereals and whole milk daily but no eggs or vegetables. For the first twelve months of his life he had no vitamin C, but had sufficient

ascorbic acid in the following months. One to two teaspoons (from about 4 to 8 cc.) of cod liver oil was given daily from the age of two weeks.

On admission, roentgenograms of the long bones revealed: (1) broad growth lines at the ends of all the long bones, (2) stippling of the distal femoral epiphyses, (3) fragmentation of the distal fibular epiphyses, (4) a periosteal line along the lateral aspects of the right femur and left tibia and (5) pronounced periosteal thickening on the posterior and medial aspects of the ulnar bones.

After a nineteen day stay in the hospital and a stay of three weeks at home he was readmitted. The mother admitted the following medication had been given the boy: (1) a preparation of vitamin B complex, 2 teaspoons daily; (2) one dicalcium phosphate capsule daily, (3) 325 mg. of saccharated ferrous carbonate twice daily; (4) 50 mg. ascorbic acid daily, (5) percomorph liver oil with viosterol (Mead), 1 teaspoon daily from the newborn period for twenty one months and then 2 teaspoons daily until the time of admission, a period of approximately three months. His symptoms had begun shortly after the vitamins were increased. During his two hospital admissions, the last preparation had not been given and his symptoms improved.

The authors believe they cannot definitely rule out some effect due to hypervitaminosis D. —*R. S. Bromer.*

TROXLER, EULYSS R., and NIEMETZ, DAVID. Generalized xanthomatosis with pulmonary, skeletal and cerebral manifestations. *Ann. Int. Med.*, Dec., 1946, *25*, 960–968.

The authors report their findings in a white male, aged thirty-five, who was known to have had xanthomatosis for at least nine years. He had the usual destructive bone lesions which were followed during this span of years. Diabetes insipidus was also present.

The chest findings were unusually interesting. The patient's lungs were first considered abnormal almost eight years previously. They were thought to be tuberculous but the diagnosis was abandoned when no acid-fast bacilli were found. Chest pain, dyspnea, and spontaneous pneumothorax developed. Roentgenograms of the chest revealed marked diffuse pulmonary fibrosis which was considered part of his xanthomatosis. The spontaneous pneumothorax was bilateral. The bone lesions were irradiated; pituitrin was given to control the diabetes insipidus; the lungs were not irradiated because of the severe pulmonary fibrosis. The patient has remained relatively well.—*Philip J. Hodes.*

GILL, DOROTHY. Multiple myeloma simulating hyperparathyroidism. *Ann. Int. Med.*, June, 1946, *24*, 1087–1093.

This case report deals with a thirty-eight year old woman who complained of intestinal distress and shoulder pain. She had been ill seven months.

The physical examination was negative except for a cachexia. She was anemic. Blood chemistry revealed A-G ratio of 47, non-protein nitrogen of 40 mg. per cent and serum calcium of 16 mg. per cent. Serum phosphorus was 2.9 mg. per cent and alkaline phosphatase 1.9 Bodansky units. The urine was negative.

Roentgenograms of the bones revealed extensive destruction of almost the entire skeleton. A diagnosis of hyperparathyroidism was made and bilateral partial parathyroidectomy performed. Histopathologically the parathyroids were normal. No tetany developed. Following operation the blood calcium dropped to a low of 13.9. Autopsy revealed extensive myeloma.

The fact that this patient with myeloma did not reveal Bence-Jones proteinuria, elevated total blood proteins, reversed albumin-globulin ratio, and kidney insufficiency is noteworthy. The blood chemistry was certainly equivocal.

Elevated blood calcium in conditions such as myeloma and metastatic carcinoma makes one postulate the true hyperactivity of the parathyroid glands. This case report supports this condition.—*Philip J. Hodes.*

FRIEDMAN, LOUIS L., and SIGNORELLI, JOHN H. Blastomycosis. *Ann. Int. Med.*, March, 1946, *24*, 385–400.

Blastomycosis is a chronic infectious disease caused by a fungus. It is characterized by granulomatous skin and visceral lesions which may be single or multiple.

The disease is most common in the United States, particularly in Illinois and Louisiana. It has been reported from abroad but the reports are not reliable. Agricultural workers, laborers, and people living in damp unhygienic wooded areas develop the disease. No inherent immunity exists. The organism usually enters the body through the skin or respiratory tract. Occasionally it exists as a secondary invader.

The exposed body surfaces, particularly the face, are most commonly affected. It may be localized or have a multiple distribution. The center of the lesion tends to heal as the margins spread with indurated violaceous appearance.

Forty or fifty per cent of all cases of blastomycosis are probably systemic. The lungs are usually responsible for the dissemination but the latter may be due to neglected cutaneous lesions. It is more common for the systemic type of the disease to involve the skin than it is for the cutaneous variety to involve the viscera. Although the organism has a predilection for skin, lungs, bones and joints, no tissue is immune to attack. Blastomycosis of the central nervous system, however, is very uncommon.

In systemic disease the lungs are most frequently involved. The lesions are very similar to tuberculosis and, to make matters still more difficult, the two may exist together in the same patient. Indeed pathologists may have difficulty differentiating the two unless the organisms can be identified. At autopsy, the lungs reveal broncopneumonic lesions with small or large abscesses. Localized areas of consolidation, caseation, and nodulation are frequent. Pleural thickening and adhesions are common. About 50 per cent of the patients with systemic disease autopsied reveal associated bone or joint disease.

The signs and symptoms are those of any other chronic infection. In more than half the patients, the onset of blastomycosis is associated with bronchopulmonary symptoms, chills, fever, anemia and leukocytosis. The skin lesions are usually painless unless they involve the deeper tissues.

A presumptive diagnosis can be made on the over-all clinical picture and the typical skin lesions. Laboratory aids to identify the organism are essential. A complement fixation test and a skin test exist which may help to establish the diagnosis although false positive results are not rare.

The prognosis in the cutaneous type is good as far as life expectancy is concerned but may be resistant to treatment. The outlook is uniformly bad in systemic disease where 90 per cent is accepted as the usual mortality rate.

The treatment is discouraging. Potassium iodide and arsphenamine have enjoyed a popularity which they do not merit. Many other drugs have also been of questionable value. Radium and roentgen rays have also been used without startling results.

Desensitization in systemic disease has been advised and used with questionable effect. Immune serum, intravenous tincture of iodine, and rectal ether have been credited with cures. Penicillin apparently is without value.

The authors report their complete findings in a patient who came to postmortem study. His history was of about two and a half months' duration. His illness started with malaise and weakness followed by the appearance of many skin lesions on his face. He lapsed into coma and was treated for neurosyphilis. In addition to the many skin lesions, the patient developed a lesion on his left upper lobe which looked tuberculous roentgenographically. The lung lesion then spread rapidly through both lungs before death. At autopsy multiple small firm gray nodules 2 to 3 mm. in diameter and larger were observed. The meninges of the brain and spinal cord were also involved. Extensive basilar exudation with thick proliferative tissue at the base of the brain was observed.—*Philip J. Hodes.*

ROENTGEN AND RADIUM THERAPY

Case, James T. Radiation injuries. Editorial. *Surg., Gynec. & Obst.*, Oct., 1947, *85*, 541–543.

For the removal of foreign bodies under the fluoroscope an accumulated time of ten minutes at 3 milliamperes will emit the maximum radiation which should be utilized in any given case. No one, surgeon or radiologist, should participate in such operations any oftener than occasionally, certainly not routinely.

There are numerous ways of accomplishing satisfactory removal of foreign bodies by other than fluoroscopic means; in fact, it is now often possible to substitute for potentially dangerous roentgen-ray methods the use of electronic or telephonic foreign body finders. Radiologists should be among the first to urge the adoption of these non-radiological methods because they offer a means of by-passing the danger inherent in the roentgen method.

Every piece of diagnostic equipment used for fluoroscopy should have a built-in protecting filter of 1.0 millimeter of aluminum or its equivalent, and under no circumstances should this be removed. The size of the field of illumination on the screen should be reduced to the very minimum. Long-handled forceps should be employed. The image of the bones of the hands of the operator or radiologist should never be seen on the fluoroscopic screen. The roentgen

tube should never be activated even for a second unless the observer's eyes are focused upon the screen ready for instant observation, and in no case should the apparatus be excited until after the observer's eyes have been thoroughly adapted to the dark.

Between 1919 and 1935 there were seen at the Mayo Clinic 135 physicians with roentgen-ray injuries, of whom 91 contracted their injuries during fluoroscopic fracture reduction. Of these 78 admitted failure to take protective precautions, and 11 confessed that they began the use of protective gloves only after sustaining the injury.

It might be assumed that radiologists are so conscious of the hazards of their speciality that they do not need to be reminded of these dangers, but a survey of forty-five hospitals showed that both radiologists and technicians received considerably more radiation during fluoroscopy than they were aware of. These exposures were the most excessive noted in the survey. Cutaneous effects varying from atrophy of the skin to the formation of epithelioma were noted in 20 per cent of the radiologists seen in the hospitals of this survey.—*Mary Frances Vastine.*

CONLEY, JOHN J., Cancer of the mouth. *Bull. Connecticut State Dental Assn.*, Nov., 1946.

The malignant tumors of the mouth are in the great majority of instances primary growths. They may originate in the bone or soft tissues and manifest themselves by tumor formation or ulceration. When the cancer has developed to the stage where the patient recognizes it, it is often far advanced. In a country where oral consciousness is so acute, the dental profession is in a strategic position not only to assist the surgeon in the active care of such patients but to search out premalignant and early malignant lesions and direct the proper course of treatment.

The author discusses in general the types of neoplasms occurring in various anatomical regions comprising the lips, the tongue, the buccal mucosa, the floor of the mouth, the alveolar ridge and gums, the tonsil and the palate. The importance of recognizing and treating precancerous lesions such as leukoplakia, papilloma, lingual warts, marginal glossitis and ulcerations and proliferations, especially in individuals past middle life, cannot be over-emphasized. It has been stated that this alone would eliminate 50 per cent of the cancers of the mouth.

Accurate diagnosis of intraoral neoplasms is essential. This is accomplished by fragment biopsy or after complete removal. Cancer may exist simultaneously with leukoplakia and syphilitic and tuberculous lesions of the mouth. Inspection of the involved area, a search of the neck and roentgen study of the adjacent bony structures and chest for possible metastases establish the pattern of therapy. The treatment is divided among surgery, irradiation and combinations of these two techniques. Radioresistant tumors and some of the early and late surgically approachable ones are treated with surgery. The radiosensitive tumors, the surgically unapproachable tumors and many of the early tumors received radiation therapy. Surgery and irradiation are often used to augment each other in attempts to control primary and recurrent cancer.—*K. K. Latteier.*

GRIFFITH, GEO. C., and HALLEY, E. P. The treatment of rheumatic fever by roentgen-ray irradiation. *Ann. Int. Med.*, June, 1946, *24*, 1039–1042.

Two hundred and one patients with rheumatic fever were included in this study. Of this group, one-third received exposures of 100 roentgens to the heart on five occasions; a second group received 100 r over the heart and over the middle and lower cervical ganglia on five occasions; a third group received no roentgen-ray exposure but were handled in much the same manner as the previous patients.

No significant change in the degree of the rheumatic fever activity was noted in any of the three groups. The cases were re-evaluated at the end of twelve and twenty-six weeks and showed no greater improvement in the treated groups over the untreated groups. Thus, no demonstrable therapeutic value from roentgen therapy was noted in the primary or recurrent attacks of rheumatic fever.—*Philip J. Hodes.*